

**FALLUJA WASTE WATER  
TREATMENT SYSTEM  
FALLUJA, IRAQ**

**SIGIR PA-08-144  
SIGIR PA-08-145  
SIGIR PA-08-146  
SIGIR PA-08-147  
SIGIR PA-08-148**

**OCTOBER 27, 2008**



Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE <b>27 OCT 2008</b>		2. REPORT TYPE		3. DATES COVERED <b>00-00-2008 to 00-00-2008</b>	
4. TITLE AND SUBTITLE <b>Falluja Waste Water Treatment System Falluja, Iraq</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>Office of the Special Inspector General for Iraq Reconstruction, 400 Army Navy Drive, Arlington, VA, 22202</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>Same as Report (SAR)</b>	18. NUMBER OF PAGES <b>90</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			





# SIGIR

Special Inspector General for Iraq Reconstruction

October 27, 2008

## Falluja Waste Water Treatment System

**Reports: PA-08-144 to 08-148**

### Why SIGIR Did This Study

In July 2008, the U.S. Ambassador became “extremely concerned” that the Falluja Waste Water Treatment System had “gone so far off track and for so long.” This project was originally planned to cost \$32.5 million, be completed in 18 months in January 2006 by one contractor, and serve the entire city of Falluja, now costs \$98 million, will only be partially completed in April 2009 under the original contract and 45 others, and serve only 38 % of the homes in the city of Falluja.

The Ambassador was concerned not only with the costs, timeliness, and extent of construction, but also with the adequacy of progress reporting. This report by the Inspections Directorate of SIGIR addresses the Ambassador’s concerns with the costs, timeliness, and extent of construction.

### What SIGIR Recommends

SIGIR recommends that the Iraq Transition Assistance Office Director coordinate efforts with the Government of Iraq to ensure that an adequate amount of fuel is provided until permanent, reliable power is available to operate the wastewater treatment plant and pump stations; ensure a solution to permanent power; guarantee that house connections are made to tie the three collection areas into the sewer network system; and ensure that the remaining contractors with outstanding balances from the Development Fund for Iraq contracts are paid.

In commenting on a draft of this report, the U.S. Embassy-Iraq concurred with the recommendations in the report. Specific comments were also provided to clarify technical aspects of the report. The Gulf Region Division of the U.S. Army Corps of Engineers also provided technical comments for clarification.

*For more information, contact SIGIR Public Affairs at (703) 428-1100 or [PublicAffairs@sigir.mil](mailto:PublicAffairs@sigir.mil)*

### What SIGIR Found

The project, now over two years behind schedule, has been de-scoped and has tripled in cost. On September 22, 2008, SIGIR preformed an on-site assessment and found that the earliest completion date is April 2009, and the system will only be partially functioning, serving only 9,300 homes or 38% of the homes originally planned.

The Falluja Waste Water Treatment System project results will not be consistent with either the original or revised project objectives. During the site visit, SIGIR confirmed that the original designs for all three collection systems were technically inadequate, and the concrete at Pump Station F1 was improperly poured.

House connection pipes were to be placed within one meter of the property line, and the Ministry of Municipalities and Public Works would make the connections from each house to the collection system. In a cost-saving measure, the Ministry proposed that each homeowner make the connection to the collection system. The problem with this proposal is that homeowners may simply knock a hole through the manhole walls and damage the collection system. Without house connections to the collection systems, there is no method of transferring wastewater from individual houses to the wastewater treatment system. Because funding is not in place to perform the house connection work, Falluja residents will not benefit from the wastewater treatment system.

Currently, no contract exists to provide the fuel needed to operate the generators at the waste water treatment plant and pump stations. This sustainability issue presents a serious problem for both the U.S. government and the Government of Iraq. Specifically, if the Government of Iraq cannot provide an adequate amount of fuel to continuously operate the waste water treatment plant and pump stations, the Falluja Waste Water Treatment System will not operate, and the substantial investment by the U.S. government will be wasted.







## **SPECIAL INSPECTOR GENERAL FOR IRAQ RECONSTRUCTION**

October 27, 2008

MEMORANDUM FOR COMMANDING GENERAL, MULTI-NATIONAL FORCE-IRAQ  
COMMANDING GENERAL, JOINT CONTRACTING COMMAND-  
IRAQ/AFGHANISTAN  
COMMANDING GENERAL, GULF REGION DIVISION, U.S.  
ARMY CORPS OF ENGINEERS  
DIRECTOR, IRAQ TRANSITION ASSISTANCE OFFICE

SUBJECT: Report on the Falluja Waste Water Treatment System, Falluja, Iraq  
(Report Number SIGIR PA-08-144, 145, 146, 147, and 148)

We are providing this report for your information and use. It addresses construction work performed on the Falluja Waste Water Treatment System in Falluja, Iraq. The U.S. Ambassador to Iraq requested the assessment because of concerns with the costs, timeliness, and extent of work performed as well as the adequacy of progress reporting. This report by the Inspections Directorate of the Special Inspector General for Iraq Reconstruction (SIGIR) addresses the Ambassador's concerns with the costs, timeliness, and extent of construction. The Audit Directorate is addressing the Ambassador's concerns with the adequacy of progress reporting in Report Number SIGIR-09-007, "Improvements Needed in Reporting the Status of Reconstruction Projects to Chief of Mission."

Comments on a draft of this report from the U.S. Embassy-Iraq and from the Gulf Region Division of the U.S. Army Corps of Engineers concurred with our recommendations and provided technical comments for clarification. As a result, no additional comments are required.

We appreciate the courtesies extended to our staff by representatives of the Iraq Transition Assistance Office, the Gulf Region Division, Gulf Region Central, and the Camp Falluja Resident Office of the U.S. Army Corps of Engineers. If you have any questions please contact Mr. Brian Flynn at [brian.flynn@sigir.mil](mailto:brian.flynn@sigir.mil) or at 703-343-9244. For public queries concerning this report, please contact SIGIR Public Affairs at [publicaffairs@sigir.mil](mailto:publicaffairs@sigir.mil) or at 703-428-1100.

Stuart W. Bowen, Jr.  
Inspector General



## Special Inspector General for Iraq Reconstruction

**SIGIR PA-08-144**  
**SIGIR PA-08-145**  
**SIGIR PA-08-146**  
**SIGIR PA-08-147**  
**SIGIR PA-08-148**

**October 27, 2008**

### **Falluja Waste Water Treatment System** **Falluja, Iraq**

#### **Synopsis**

**Introduction.** In July 2008, the U.S. Ambassador became “extremely concerned” that the Falluja Waste Water Treatment System<sup>1</sup> had “gone so far off track and for so long.” Specifically, a project that was originally planned to cost \$32.5 million, be completed in 18 months in January 2006 by one contractor, and serve the entire city of Falluja, now would cost \$98 million, be only partially completed in 56 months in April 2009 under the original contract and 45 subsequent contracts, and serve only 9,300 homes—only 38% of the city of Falluja. The Ambassador was concerned not only with the costs, timeliness, and extent of, but also with the adequacy of progress reporting. This inspection report addresses the Ambassador’s concerns with the costs, timeliness, and extent of construction. The Audit Directorate is addressing the Ambassador’s concerns with the adequacy of progress reporting in Report Number SIGIR-09-007, “Improvements Needed in Reporting the Status of Reconstruction Projects to Chief of Mission.”

On 23 March 2004, an indefinite delivery/indefinite quantity, cost-plus award-fee contract to restore, rebuild, and develop water, wastewater, and solid waste projects to assist in the restoration of the Iraqi infrastructure, was awarded to FluorAMEC of Greenville, South Carolina. On 26 June 2004, a delivery order against the contract for \$32.5 million was issued to design and construct a new wastewater treatment system, comprising a sewer collection network, trunk lines, pump stations, and a wastewater treatment plant for the city of Falluja. The projected start date was 1 July 2004; the project was scheduled to be completed in 18 months. In September 2005, after the project experienced schedule delays and cost growth of approximately \$25.8 million, the Iraq Reconstruction Management Office<sup>2</sup> terminated the original FluorAMEC contract. At that time, only a portion of one collection network was complete. Since then, 45 separate contracts have been awarded to multiple Iraqi contractors to complete portions of the wastewater treatment system and provide needed equipment and supplies. At the time of the SIGIR assessment, the costs of the Falluja Waste Water Treatment System had risen to approximately \$98 million, of which \$18.7 million had been expended under the FluorAMEC delivery order and \$79.3 million obligated for the 45 contracts to complete the system.

---

<sup>1</sup> The Falluja Waste Water Treatment System project is also referred to in various documents related to it as the Falluja Sewage Network project, Falluja Sewer Distribution Network project, and Falluja Sewer Network. For consistency within this report, unless used in a verbatim quotation, we refer to it as the Falluja Waste Water Treatment System.

<sup>2</sup> In 2007, Iraq Reconstruction Management Office became the Iraq Transition Assistance Office.



SIGIR subjectively chose five contracts to review in this assessment report. The contracts selected provide coverage of all three funding sources and multiple facets of the project, including sewer collection Area A, the force main, and the wastewater treatment plant.

**Project Assessment Objectives.** The objective of these project assessments was to provide real-time information on relief and reconstruction projects to interested parties to enable appropriate action, when warranted. Specifically, SIGIR determined whether:

1. Project components were adequately designed prior to construction or installation;
2. Construction or rehabilitation is in compliance with the standards of the design;
3. Adequate quality management programs were being utilized;
4. Sustainability was addressed in the contract or task order for the project; and
5. Project results were or will be consistent with their original objectives.

SIGIR conducted these project assessments in accordance with the Quality Standards for Inspections issued by the President's Council on Integrity and Efficiency. The assessment team comprised an engineer/inspector and two auditor/inspectors.

**Project Objective.** The original objective of the FluorAMEC contract delivery order was to design and construct a wastewater treatment system to serve the then-estimated 24,400 homes in the entire city of Falluja. The system was to include eight sewer collection networks, trunk and force main pipelines, seven pump stations, a wastewater treatment plant, and an effluent pump station with outfall to the Euphrates River. However, the objective was ultimately modified to design and construct collection systems for 9,300 homes in only three of the eight areas within the city of Falluja, trunk and force main pipelines, three pump stations, a wastewater treatment plant, and an effluent pump station with outfall to the Euphrates River.

Costing approximately \$98 million,<sup>3</sup> the Falluja Waste Water Treatment System is the only major new sewage system being constructed and one of the largest water projects funded by the U.S. government in Iraq. This project has been identified as a priority project for the U.S. government and the Government of Iraq because it is to provide sewage treatment for a predominantly Sunni area.

**Issues Affecting the Costs, Timeliness, and Extent of Construction.** Although several factors contributed to the project slipping drastically behind schedule and escalating costs, the main reasons involve:

- unrealistic expectations by the U.S. government with regard to schedule and cost estimates considering the security situation
- the decision to redesign the wastewater treatment plant from a lagoon system to an activated sludge system
- funding and contracting issues
- indecision by the U.S. government with regard to identifying a path forward for this project
- limited contractor and subcontractor pool to choose from and the resulting quality issues
- workplace safety issues at the project sites

---

<sup>3</sup> The \$98 million comprises \$18.7 million expended under the FluorAMEC contract delivery order and \$79.3 million in contracts obligated to complete the Falluja Sewer Network project. This number is subject to increase due to pending contracting actions, such as contract modifications and awards of new contracts.



**Conclusions.** The assessment determined that:

1. The wastewater treatment plant for the Falluja Waste Water Treatment System was originally designed using a lagoon system; however, because the Iraqi Ministry of Municipalities and Public Works refused to even consider a lagoon system, the U.S. government agreed to re-design the wastewater treatment plant using a mechanical system (activated sludge units). According to representatives of the Iraq Transition Assistance Office and the U.S. Army Corps of Engineers, the design drawings for both the wastewater treatment plant and the pump stations were “technically inadequate,” which required the U.S. government to contract with Washington International, Inc./Black and Veatch to complete the construction package. For example, the contractor’s design submittal for the wastewater treatment plant had “many technical issues” requiring Washington International, Inc./Black & Veatch to develop detailed designs for the chlorination system, scrubber, polymer slab, and polymer system design. In addition, a peer design review was required to bring the pump stations “up to international safety and engineering code compliance.” Also, the original designs for all three collection systems were technically inadequate because the original design engineer was unable to complete site surveys because of security concerns.

After the project was re-designed two separate times at significant additional cost to the U.S. government, the contract’s design and specifications were eventually revised to be specific enough to construct the wastewater treatment plant and associated facilities. The revised design has taken into consideration the sequencing of work and the relationship to other contract work. The revised drawings and specifications appear to be complete and consistent with the contract’s requirements. However, it must be noted that the primary design concern of the Ministry of Municipalities and Public Works--the odor produced by a lagoon system--was not addressed by the original design of the wastewater treatment plant with the activated sludge units. During the design review process, this was identified; however, because of project funding constraints, it was not remedied. Consequently, the residents of Falluja, many of whom will not have access to the sewer system, may be subjected to significant odors emitted from the wastewater treatment plant.

2. The majority of the work observed met the standards of the revised designs. Because of the security situation, the inspection team was able to inspect only the wastewater treatment plant and Pump Station F1. At the wastewater treatment plant, no significant deficiencies were observed; however, at Pump Station F1, the inspection team observed an area of inadequately poured concrete. According to a representative of the Camp Falluja Resident Office of the U.S. Army Corps of Engineers Gulf Region Central, the unacceptable concrete work had previously been identified on a deficiency list and will be inspected for removal and replacement prior to issuance of final payment. The inspection team concluded that the Camp Falluja Resident Office provided adequate oversight to ensure that construction met the standards of the design.
3. The contractors’ quality control plans were sufficiently detailed, including the use of daily quality control reports to document construction deficiencies. The daily quality control reports documented the number of workers on site, the construction activities performed, and provided numerous photographs of work activities performed. According to Camp Falluja Resident Office representatives, the contractor’s daily quality control reports were useful but showed what the contractor wanted them to see.



The government quality assurance program was effective in ensuring that construction of the entire Falluja Waste Water Treatment System was adequate. The security situation in and around this project has been extremely volatile, which severely limited the ability of Camp Falluja Resident Office representatives to perform the depth of quality assurance oversight required for a project this large and complex. The constant threat of attacks either on site or during the drive to and from the site limited the frequency and duration of Camp Falluja Resident Office representatives' project visits to an hour or two every other week.

Technical precision and contractor safety issues for the wastewater treatment system required more quality assurance oversight than the Camp Falluja Resident Office could provide because of the security situation. Therefore, a contract was awarded to a local contractor that employed Iraqi engineers from the Falluja area as quality assurance representatives to perform field engineering and inspections services during construction. The quality assurance representatives were on site during construction events, monitored field activities, and completed daily quality assurance reports, which documented significant construction activities and included photographs of construction work performed throughout the day. According to Camp Falluja Resident Office representatives, the quality assurance representatives served as their "eyes and ears on the ground."

The lack of local contractors with the technical capabilities to perform construction activities that comply with international standards presented a constant challenge. According to Camp Falluja Resident Office representatives, their goal was to achieve a "minimum acceptable quality" at the project sites, which they believed was a realistic approach to managing this project. Camp Falluja Resident Office representatives believe that this goal does not mean diminished quality, but rather a practical approach when taking into consideration security, safety, and the desire for project progress.

Camp Falluja Resident Office representatives have instituted improved concrete specifications for the wastewater treatment plant and pump stations, which provided vastly improved durability from higher concrete density and provided concrete compressive strength test results that are well above the minimum required characteristic strength. Camp Falluja Resident Office representatives consider this an "insurance policy" to overcome the "inherent flaws in concrete production and placement that exist in the Iraqi construction industry at present." In addition, Camp Falluja Resident Office representatives mentor the local Iraqi contractors with safety briefings and construction techniques. Throughout the duration of this project, Camp Falluja Resident Office representatives made a concerted effort to promote safety as much as quality with the local contractors. Several accidents have occurred at the project sites—resulting in four fatalities. The deaths are a testament to the failure of the local contractors to conform to the safety practices recommended by the Camp Falluja Resident Office representatives.

The Camp Falluja Resident Office's robust quality assurance program compensated for the technical and safety limitations of the local contractors. Specifically, the quality assurance program encouraged safety and quality while ensuring the completion of the project.

4. Sustainability was not adequately addressed for this project. At the inception of the project, the U.S. government wanted the wastewater treatment plant to consist of a lagoon system because it required little power, no skilled personnel, and little maintenance to operate; however, the Iraqi Ministry of Municipalities and Public



Works rejected the lagoon system because it was for “third-world countries.” Instead the Ministry of Municipalities and Public Works requested the use of a mechanical (activated sludge unit) system. Ultimately, the U.S. government accepted the Ministry of Municipalities and Public Works proposal of using a mechanical system; this decision will have significant, irreversible, and long-term ramifications on the future operation and maintenance of the wastewater treatment plant and associated facilities.

When the original delivery order was awarded in mid-2004, little permanent power was required because the wastewater treatment plant was designed with a lagoon system. In November 2005, when the U.S. government agreed to redesign the wastewater treatment plant from a lagoon to a mechanical system, the need for permanent, reliable power became critical. In June 2006, a contract funded with Development Fund for Iraq funds was awarded to provide power to operate the newly designed mechanical wastewater treatment plant and Pump Station F1--specifically, feeder lines connecting the plant and pump station to a local substation.

However, by July 2007, U.S. government representatives realized that the Iraqi National Grid would not provide “any significant improvements [for permanent power] in the foreseeable future.” As a result, the solution to the lack of permanent power was to further redesign the wastewater treatment plant to operate by continuous-use generators instead of standby generators.

According to Gulf Region Division representatives, it will take approximately 520 gallons of fuel per hour (12,480 gallons per day) to operate the generators for the full running of the wastewater treatment system (all four wastewater treatment plant trains and three pump stations for eight collection areas); although it will require 200-250 gallons of fuel per hour (4,800 – 6,000 gallons per day) to operate the limited service portion of this project (two of the four wastewater treatment plant trains and two pump stations for three collection areas).

Currently, no contract exists to provide the fuel needed to operate the generators at the wastewater treatment plant and pump stations. The inspection team was told that the Ministry of Municipalities and Public Works would be responsible for providing the fuel. Unfortunately, the Ministry of Municipalities and Public Works has not yet committed to providing the fuel that will be required to run the wastewater treatment plant and three pump stations.

This sustainability issue presents a serious problem for both the U.S. government and the Government of Iraq. Specifically, if the Government of Iraq cannot provide an adequate amount of fuel to continuously operate the wastewater treatment plant and pump stations, the Falluja Waste Water Treatment System will not operate, and the substantial investment by the U.S. government will be wasted.

5. The results of the Falluja Waste Water Treatment System project will not be consistent with either the original or revised project objectives. Originally, the project objective was to provide a comprehensive wastewater treatment system for the entire city of Falluja; however, due to significantly increased costs and project delays, the objective was modified to provide the backbone to the wastewater treatment system (i.e. wastewater treatment plant, pump stations, and trunk lines) and make it available to only three of Falluja’s eight collection areas. The original intent was to provide house-connection pipes to within one meter of the property line, and the Ministry of Municipalities and Public Works would be responsible for making the connections from each house to the collection system. In a cost-saving measure, the Ministry has proposed allowing each homeowner to make the connection to the collection system.



Camp Falluja Resident Office representatives are concerned about this proposal: they believe homeowners will simply knock a hole through the manhole walls, damaging the collection system. Without house connections to the collection systems, there will be no method of transferring wastewater from individual houses to the wastewater treatment system. Currently, neither the U.S. government nor the Government of Iraq has funding in place to perform the house connection work; therefore, no Falluja residents will benefit from the wastewater treatment system.

In addition, a number of contractors with contracts funded by the Development Fund for Iraq have not received payment for their work on the wastewater treatment system for extended time periods. For example, the contractor who constructed the Force Main pipeline is owed approximately \$1.3 million by the Iraqi Ministry of Finance under his contract. The Iraq Transition Assistance Office has been actively pursuing the payment of the Development Fund for Iraq funded contracts with the Ministry of Finance. Subsequent to the issuance of the draft report, the Iraq Transition Assistance Office representatives stated that two payments, totaling approximately \$570,000, have been made by the Ministry of Finance.

According to U.S. government representatives, the Ministry of Finance is “days away” from making the payment to the contractor; however, this payment is almost two years overdue. Until payment is received, the contractor has denied use of the Force Main pipeline to the wastewater treatment system by locking the manholes and valve boxes. Without the use of the Force Main pipeline, no wastewater will travel from Pump Station F1 to the wastewater treatment plant.

**Recommendations.** To protect the U.S. government’s investment of approximately \$98 million, SIGIR recommends that the Iraq Transition Assistance Office Director:

1. Coordinate efforts with the Government of Iraq to ensure that an adequate amount of fuel is provided until permanent, reliable power is available to operate the wastewater treatment plant and the pump stations.
2. Coordinate efforts with the Government of Iraq to ensure a solution to permanent power for the wastewater treatment plant and pump stations.
3. Coordinate with the Government of Iraq to guarantee that the house connections are made to tie the three collection areas into the sewer network system.
4. Continue efforts with the Government of Iraq to ensure that the remaining contractors with outstanding balances from the Development Fund for Iraq contracts are paid.

**Management Comments.** SIGIR received comments on the draft of this report from the U.S. Embassy-Iraq, concurring with the recommendations in the report. Specific comments were also provided to clarify technical aspects of the report. The Gulf Region Division of the U.S. Army Corps of Engineers also provided technical comments for clarification. SIGIR reviewed the comments provided by both the U.S. Embassy-Iraq and the Gulf Region Division and revised the final report as appropriate.

**Evaluation of Management Comments.** SIGIR appreciates the concurrence by the U.S. Embassy-Iraq with the draft report’s recommendations to coordinate efforts with the Government of Iraq to ensure an adequate amount of fuel is provided, a solution to the permanent power required to operate the wastewater treatment plant and pump stations, and house connections are made; while continuing to pursue payment with the Government of Iraq for the outstanding balances owed to contractors who performed under Development Fund for Iraq funded contracts.



SIGIR reviewed the information and clarifying comments provided by the U.S. Embassy-Iraq and the Gulf Region Division and revised the final report as appropriate. However, SIGIR disagrees with the U.S. Embassy-Iraq's clarifications regarding the house connections and number of Falluja citizens to be serviced by the wastewater treatment system. Specifically, the issue is the Ministry of Municipalities and Public Works connecting the individual houses to the collection system pipeline. The Ministry of Municipalities and Public Works may have "verbally committed" to completing the connections; however, according to the Gulf Region Division, the Ministry does not have available funding to perform this work. Instead, the Ministry is proposing to allow each homeowner to make his own connection to the collection system; a proposal U.S. Army Corps of Engineers representatives are "extremely concerned" about, because homeowners likely will damage the collection system.

As a result, Gulf Region Division representatives have stated that if the Ministry cannot fund the house connections, the "back up plan" is for the U.S. government to use Economic Support Funds. Until this issue is addressed and resolved, the residents of Falluja will not benefit from the wastewater treatment system. In addition, the "flow of sewage in completed parts of the sewer network" does not indicate that "some connections have already been completed;" any sewage in the network is the result of illegal taps into the system, which SIGIR covers in the body of this report. In addition, according to the Gulf Region Division documentation, the design capacity of the wastewater treatment plant is 40,000 cubic meters per day, not 48,000 cubic meters per day. Also, since the population continues to expand due to security improvements, it is not certain that the entire system, when completed, will be able to sufficiently accommodate all citizens of Falluja.

The original objective of this project was to provide a wastewater treatment system for the entire city of Falluja (eight collection areas), which will require the wastewater treatment plant to simultaneously employ all four treatment trains and three individual pump stations operating at design capacity. The Gulf Region Division agrees with our assessment that to operate the entire wastewater treatment system at its designed capacity, 520 gallons of fuel per hour (12,480 gallons per day) will be required. However, the Gulf Region Division stated that since the project has been de-scoped to only service three collection areas, less fuel is required. Specifically, the U.S. government is projecting the wastewater treatment system will be partially operational in April 2009 (only two of the four wastewater treatment plant trains and two pump stations), for which the Gulf Region Division estimated that 200-250 gallons of fuel per hour (4,800 – 6,000 gallons of fuel per day) will be required.

Gulf Region Division representatives have previously stated that the Government of Iraq "will not be left in a difficult situation without any warning, as coordination efforts will be made in advance" regarding the fuel issue. The wastewater treatment system will be partially operational in April 2009; the Government of Iraq needs to quickly implement a system in place to provide a total of at least 4,800 – 6,000 gallons of fuel per day to multiple sites throughout the city of Falluja on a daily basis. However, after the Government of Iraq completes the remaining portions of the wastewater treatment system, this requirement will escalate to 12,480 gallons per day. The lack of fuel, even if for only a single day, could result in the back up of wastewater into the houses of Falluja residents.



# Table of Contents

---

<b>Synopsis</b>	i
<b>Introduction</b>	
Background	1
Objective of the Project Assessment	2
Pre-Site Assessment Background	3
Contract, Costs and Payments	3
Project Objective	3
Pre-Construction Description	4
Statement of Work	5
Request for Assessment	6
Unrealistic Expectations	7
Design Change – Lagoon System to Activated Sludge System	11
Funding and Contracting Issues	16
Indecision by U.S. Government Officials	23
Limited Contractor Pool and Resulting Quality Issues	25
Workplace Safety Issues at Project Sites	25
Current Project Design and Specifications	28
<b>Site Assessment</b>	32
<b>Project Quality Management</b>	44
<b>Sustainment</b>	49
<b>Additional Challenges</b>	52
<b>Conclusions</b>	53
<b>Recommendations</b>	56
<b>Management Comments</b>	57
<b>Evaluation of Management Comments</b>	57
<b>Appendices</b>	
A. Scope and Methodology	59
B. Sanitation Services/Waste Water Treatment Plants	60
C. Individual Contracts Awarded	61
D. U.S. Government Response to MMPW Over Concerns With Lagoon System	63
E. Technical Comparison of Treatment Systems	65
F. Falluja WWTP DFI Payments as of 31 December 2007	66
G. Falluja WWTP DFI Payments as of 4 August 2008	67
H. GRD Comments	68
I. U.S. Embassy-Iraq Comments	72
J. Public Notice to Falluja Residents	74
K. Acronyms	75
L. Report Distribution	77
M. Project Assessment Team Members	79



# Introduction

---

## Background

Prior to the 1991 Gulf War, Iraq had a relatively high level of water supply and sanitation services, which operated efficiently utilizing then-current technologies. Sanitation service covered approximately 75% for urban communities, of which 25% were connected to centralized sewerage systems and 50% with on-site septic tank systems. However, coverage for rural areas was approximately 40% and consisted mainly of pour flush latrines.

Prior to the second Gulf War, Iraq had 16 existing, major wastewater treatment plants (WWTPs)<sup>4</sup>, which treated only 20% of Iraq's total sewage; the remaining sewage posed a human threat by standing idle in the streets or dumped into the rivers. The sewerage collection and treatment system served mainly the city of Baghdad, where it reached approximately 80% of the population. Approximately 9% of the urban population outside of Baghdad was served by sewerage systems while the rural areas and the north of Iraq did not have piped sewerage systems. By 2003, a majority of the WWTPs were either not working or at best only partially operational due to shortages in electrical power, spare parts, and chemicals, which resulted in unacceptable levels of treatment. In most cases, the existing WWTPs were simply being used to pass along the wastewater, which resulted in the wastewater going directly into the rivers and waterways. In addition, another problem was the illegal discharge of septic sewage collected from homes into rivers or on land. The nonoperational sanitation system, with limited capacity, posed a serious environmental and health concern.

### **Need for Waste Water Treatment Plant in the City of Falluja**

#### *Anbar Governorate*

The Anbar Governorate, located in western Iraq, is bordered by Syria, Jordan, and Saudi Arabia. It is the largest province in the country with approximately one third of the area of Iraq. An estimated population of 1.28 million people is distributed among cities such as Ramadi, the province capital, and Falluja.

#### *Falluja*

Falluja lies approximately 80 kilometers (km) west of Baghdad and is one of the largest cities in Anbar Governorate. The city of Falluja measures approximately 3-km wide by 3.5-km long. The surface topography for the city of Falluja is at or below the elevation of the Euphrates River, leading to a shallow groundwater table throughout the city. Some parts of the city are known to be below river elevation and are also prone to flooding. The city of Falluja has incorporated a storm water collection and forced main pumping system designed to “dewater” the city. There are a number of lift stations, which pump natural occurring groundwater back into the Euphrates River.

The city of Falluja does not have a comprehensive wastewater system. Currently, the citizens of Falluja employ one of two methods for disposing of their sanitary waste. One method is using buried holding tanks to collect and store sanitary waste, with the septic holding tanks being vacuumed out by a tank truck and disposed of off-site; or a number of Falluja residences have made plumbing connections between their home septic holding tanks and the storm water collection system, which resulted in the disposal of sanitary waste directly into the Euphrates River. The discharge of raw sewage into the Euphrates

---

<sup>4</sup> Appendix B presents a more detailed description of a wastewater treatment system.



River contaminates the river water that is used by the public for several purposes, including a source of potable drinking water. In addition, sewer water runs down through the center of the city streets (Site Photo 1). Since children often play in the streets and sewer water, serious health issues, particularly among the young, exist.

In addition, according to U.S. government representatives, the city of Falluja suffers from a lack of reliable power from the national grid. The limited power available from the national grid is, at best, sporadic. When it is available it goes on and off without notice and power surges are not uncommon.



**Site Photo 1. Sewage flowing throughout Falluja city streets**

## **Objective of the Project Assessment**

The objective of this project assessment was to provide real-time relief and reconstruction project information to interested parties to enable appropriate action, when warranted. Specifically, the Special Inspector General for Iraq Reconstruction (SIGIR) determined whether:

1. Project components were adequately designed prior to construction or installation;
2. Construction or rehabilitation is in compliance with the standards of the design;
3. Adequate quality management programs are being utilized;
4. Sustainability was addressed in the contract or task order for the project; and
5. Project results are or will be consistent with their original objectives.



## **Pre-Site Assessment Background**

### **Contract, Costs and Payments**

Contract W914NS-04-D-0008, an Indefinite Delivery/Indefinite Quantity, cost-plus-award-fee contract to restore, rebuild, and develop water, wastewater, and solid waste projects to assist in the restoration of the Iraqi infrastructure, was awarded to FluorAMEC, Greenville, South Carolina, on 23 March 2004.

Delivery Order (DO) 0008, awarded on 26 June 2004, and its 15 modifications, required the design and construction of a new wastewater distribution system, consisting of a sewer distribution network through multiple collection systems and oxidation (aeration) lagoon WWTP for the city of Falluja. The initial funding was \$32.5 million in Iraq Relief and Reconstruction Fund (IRRF). The DO, with a projected start date of 1 July 2004, was scheduled to be completed in 18 months.

In September 2005, after the project experienced cost growth of approximately \$25.8 million and schedule delays, the Iraq Reconstruction Management Office (IRMO)<sup>5</sup> terminated the FluorAMEC contract after completion of only a portion of one collection system (Collection Area A). FluorAMEC was ultimately paid approximately \$18.7 million for its efforts.

Since the termination of the FluorAMEC contract, 45 separate contracts<sup>6</sup> have been awarded to complete the wastewater treatment system and provide needed equipment and supplies. For a detailed list of the 45 contracts, see Appendix C. The 45 contracts utilized multiple funding sources – IRRF, Development Fund for Iraq (DFI), and Commanders' Emergency Response Program (CERP).

SIGIR subjectively chose five contracts to review in this assessment report. The contracts provide coverage of all three funding sources and multiple facets of the project, such as earthworks for and construction of the WWTP and pump stations, repair of Collection Area A, and the Force Main. The status and quality of WWTP and pump station construction will be addressed in the Site Assessment section of this report; while the repair of Collection Area A and Force Main contracts provide examples of challenges faced by the U.S. government and will be discussed throughout the report.

### **Project Objective**

Major public health problems emerged in the city of Falluja as a result of raw sewage flooding the city streets and contaminating the river water used by the public for many purposes. To eradicate the growing health concern by treating most of the sewage collected and reducing the contamination effects on the Euphrates River, the objective of the original DO was to design and construct a wastewater treatment system network and an oxidation lagoon system WWTP.

---

<sup>5</sup> In 2007, the IRMO became the Iraqi Transition Assistance Office.

<sup>6</sup> The 45 contracts consist of the following: 15 construction contracts, 20 procurement contracts, and 10 service contracts.



The Falluja Waste Water Treatment System<sup>7</sup> project is the only major new sewage system being constructed by the U.S. government in Iraq and was identified as a “priority” by IRMO as this project was identified as a “key national reconciliation issue.” Initially, this project was funded with \$32.5 million in IRRF to design and construct a wastewater treatment system and WWTP to service the entire city of Falluja; however, the project is now approaching the \$100 million mark with IRRF, DFI, and CERP funding while being de-scoped (requirements removed contract scope of work in order to reduce costs) so that it now will only provide wastewater treatment system service to a portion of the city residents. Specifically, the project’s original intent was to provide a wastewater treatment system to service the then estimated 24,400 homes in the entire city of Falluja; this objective was ultimately modified to provide service to approximately 9,300 homes in only three of the eight areas within the city of Falluja.

### **Pre-Construction Description**

The description of the site (pre-construction) is based upon information obtained from the contract, U.S. Army Corps of Engineers (USACE) and Iraqi Transition Assistance Office (ITAO) personnel, and USACE and ITAO documentation.

#### **Location of the WWTP**

For the actual WWTP site, the Ministry of Municipalities and Public Works (MMPW) selected an area that appears to be adjacent to and including a portion of an ancient Euphrates River oxbow or lake. The site location is adjacent to a dry lake, which could make it subject to flooding. No significant flood study exists; therefore, the WWTP’s design raised it to an elevation comparable to the surrounding land.

#### **Population of Falluja**

According to USACE documentation, population studies were performed in the past. In 2002, the population of Falluja was approximately 183,000 people. However, it should be noted that significant military action occurred in Falluja in 2004-05, which changed the landscape and population of the city. Specifically, the result of heavy artillery and air dropped bombs during the fight for Falluja was that many of the homes in the Nazal district of Falluja were destroyed and the city’s population was greatly reduced. The MMPW provided recent population estimates and future population projections for the city of Falluja after the completion of the 2005 military activities (Table 1).

<b>Year</b>	<b>Population</b>
2005	190,000
2015	237,400
2025	289,400

**Table 1. Population projections for Falluja.**

---

<sup>7</sup> The Falluja Waste Water Treatment System project is also referred to in various documents related to it as the Falluja Sewage Network project, Falluja Sewer Distribution Network project, and Falluja Sewer Network. For consistency within this report, unless used in a verbatim quotation, we refer to it as the Falluja Waste Water Treatment System.



### *Previous Sewer Network System Master Plan Completed*

In the late 1980s, Ghadak Ltd Company (Ghadak) completed a master plan for an all encompassing sewer network system for the city of Falluja. Specifically, Ghadak produced a design for a sewage treatment system that included a collection network, trunk lines, and a treatment facility. The entire city of Falluja was divided into eight (8) collection areas (Figure 2). Even though the master plan was updated prior to the second Gulf War, Ghadak's master plan was never implemented due to lack of funding.

### **Statement of Work**

#### *FluorAMEC's Statement of Work*

The original FluorAMEC DO required "a sewer distribution network and an oxidation lagoons-wastewater treatment plant with a treatment capacity of 25,000 cubic meters ( $\text{m}^3/\text{day}$ ).” The original DO's Statement of Work (SOW) documented a two phase approach to the design and construction of the sewer distribution network and WWTP. Phase I consisted of the study/project assessment; while Phase II dealt with implementation.

The Phase I Study Assessment required FluorAMEC, after meeting with local consultants and obtaining all design/study documents for the city of Falluja wastewater system, to prepare a report including a design basis for the WWTP. FluorAMEC subcontracted the design to Ghadak, who utilized its previously prepared sewer network master plan.

Figure 1 is an illustration of the original design for the entire Falluja Waste Water Treatment System.



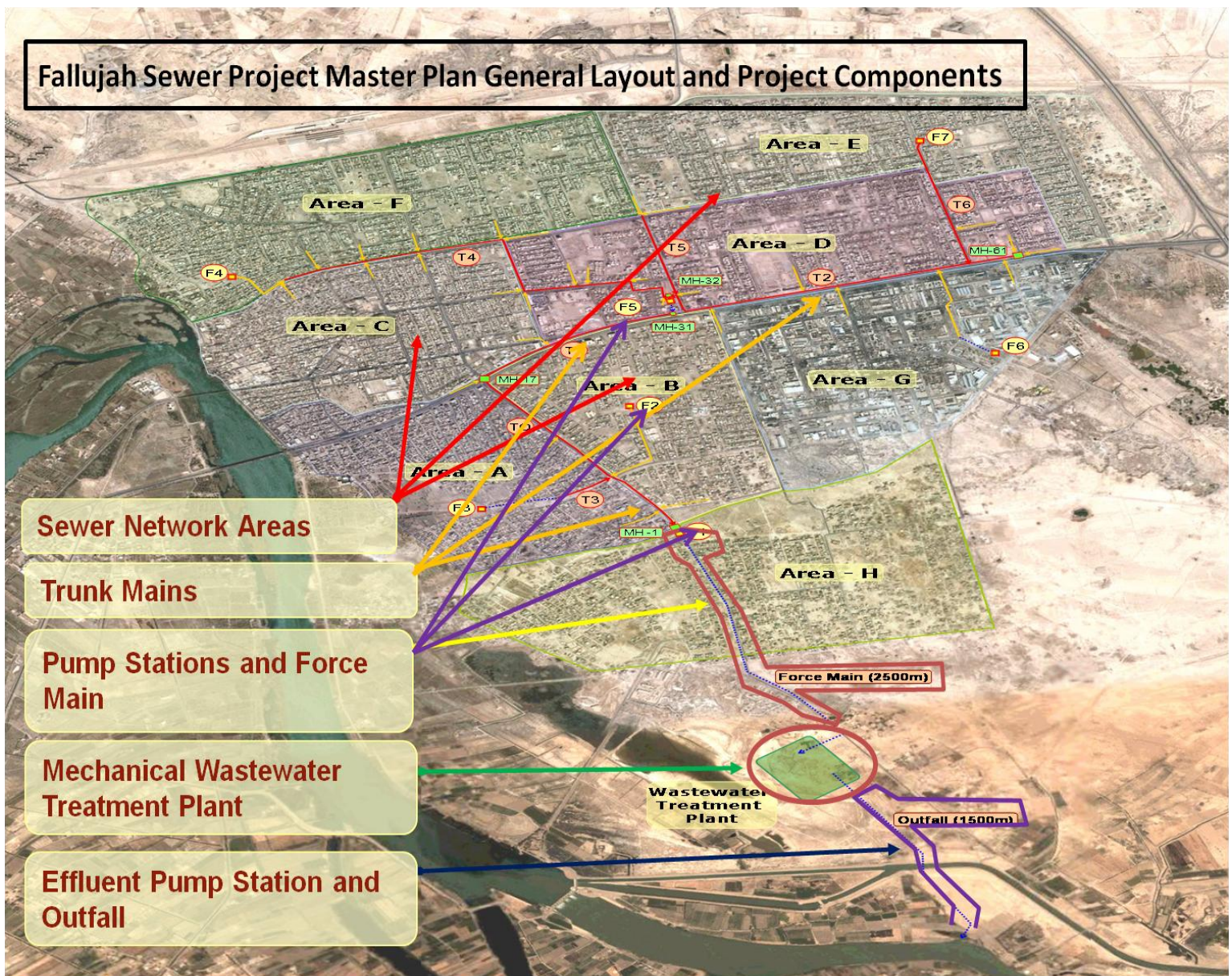


Figure 1. Original design for the entire Falluja Waste Water Treatment System  
(Courtesy of the ITAO)

## Request for an Assessment

Costing approximately \$98 million, the Falluja Waste Water Treatment System, which includes the Falluja WWTP, associated facilities and trunk lines, is the only major sewage system being constructed by the U.S. government and one of the largest water projects funded by the U.S. government. It has been identified as a priority project for the U.S. government and Government of Iraq (GOI) since it is to provide sewage treatment for a predominantly Sunni area.



In July 2008, the U.S. Ambassador became “extremely concerned” that this project had “gone so far off track and for so long.” In addition, senior managers told the U.S. Ambassador that current progress is “still very sporadic.”

The U.S. Ambassador requested that SIGIR perform an assessment of the current status of the Falluja Waste Water Treatment System’s construction and determine the causes to explain why the project was significantly behind schedule. Specifically, a project that was originally scheduled to cost \$32.5 million, be completed in January 2006, and service the entire city of Falluja, would now cost significantly more than originally scheduled, at earliest will be partially completed by April 2009, and service approximately one-third of the residents originally planned (9,300 homes out of 24,400 homes).

Several major factors contributed to the project’s drastic slip behind schedule and escalating costs:

- unrealistic expectations by the U.S. government with regards to schedule and cost estimates, considering the security situation
- the decision to redesign the wastewater treatment plant from a lagoon system to an activated sludge system
- funding and contracting issues
- indecision by the U.S. government with regard to identifying a path forward for this project
- limited contractor and subcontractor pool to choose from and the resulting quality issues
- workplace safety issues at the project sites

The quality of construction for the Falluja Waste Water Treatment System will be discussed in the Site Assessment section of this report.

## **Unrealistic Expectations**

### *Falluja at the time of contract issuance*

Located in the “Sunni Triangle,” an area north and west of Baghdad, in 2004 Falluja was considered to be Iraq’s most volatile region and a “hub for the campaign of violence aimed at destabilizing Iraq’s interim government and driving foreign military forces from the country.”

On 5 April 2004, the Marines laid siege to the city of Falluja. After approximately 5 days of heavy fighting, the Americans called a halt to the offensive for a week. Even though there was officially a cease fire, heavy fighting continued throughout April 2004. By the end of May 2004, there was no central authority in the city, which had become a lawless entity and a home to anti-Coalition forces. Throughout the summer and fall of 2004, the U.S. military conducted sporadic airstrikes against suspected militant bases in Falluja. By November 2004, the U.S. military prepared for a major offensive and stepped up daily aerial attacks. In addition, Marines engaged in daily firefights along the city’s perimeter.

In an attempt to regain the city from insurgents in preparation for national elections scheduled for January 2005, on 8 November 2004, Operation Phantom Fury<sup>8</sup> was launched. In the first stage of the assault, a Marine unit seized two strategic bridges and a hospital. On 16 November 2004, U.S. military officials announced that American troops had secured Falluja; however, there were “still sporadic instances of insurgent activity.”

---

<sup>8</sup> The Iraqi Defense Minister later renamed it Operation Dawn.



*U.S. government issues contract during the middle of kinetic operations and accelerates completion date*

On 26 June 2004, during the middle of intense military conflict between Coalition Forces (CF) and insurgents in the city of Falluja, the Coalition Provisional Authority (CPA) issued the “Falluja City Waste Water Project” to FluorAMEC. The issuance of this contract came less than three months after the Blackwater incident, in which four American private security contractors were ambushed and murdered in the city’s streets.

This project was identified as a “priority” because it represented a key reconciliation issue; it was to provide the first ever wastewater treatment system network for the city of Falluja, which at the time was a Sunni stronghold. However, it was unrealistic for the CPA to believe FluorAMEC could even begin construction, let alone complete the project, while fierce fighting occurred daily between CF and insurgents. The CPA should have realized the serious constraints FluorAMEC would encounter attempting to perform new construction throughout the city while hostilities were still ongoing. This project required the construction of a large WWTP along with a distribution network running through the entire city. In order to start this project, large pieces of equipment (such as bulldozers, cranes, and tractors) needed to be mobilized at each project site to simply begin excavation. However, in most cases throughout 2004, CF did not allow the movement of large equipment within the city. In instances when trucks were allowed into the city, they were thoroughly searched. For example, trucks hauling sand and gravel to the project sites were required to empty their contents onto the ground and then reload the contents back onto the trucks after being searched for explosives. This time consuming exercise was repeatedly done throughout the project and added considerable delays to the overall project.

Further, even after the completion of Operation Phantom Fury in mid-November 2004, the city was in ruins due to months of airstrikes and clashes between CF and insurgents (Site Photo 2). Any new construction required the removal of debris from buildings and homes, which added additional time to the completion of the project. In addition, in order for the contractor to accurately design the wastewater distribution network system (i.e. collection systems), site surveys were needed to identify the house connections required. However, this again would require the contractor to enter each neighborhood, which was receiving airstrikes and armed clashes on a daily basis. According to Gulf Region Division (GRD) documentation, the contractor attempting to conduct geo-technical and survey work was hampered by confrontations with squatters and a member of the survey party received a gunshot wound.





**Site Photo 2. Condition of the city streets in Falluja in November 2004**  
(Photo Courtesy of USACE)

In another highly questionable decision, the CPA accelerated the required project completion date from three and a half (3 ½) years from the start date to 18 months. Considering that “relative calm” did not come to Falluja until the end of November 2004, the project was already 5 months old and FluorAMEC had only 13 months to complete it. The project file lacked any documentation to identify the rationale why CPA personnel decided to speed up the project’s completion date by more than 50%.

*Falluja Waste Water Project experienced continuous security issues*

Unfortunately, this project was not immune from the city’s hostilities. Contractors had to deal with unexploded ordnance (UXO) and improvised explosive devices (IEDs) buried in trenches, threats, intimidation, murder, assassinations, and periods of city lockdown by the U.S. military. The threats of violence, both real and perceived, have caused this project to progress at a much slower rate.



According to a Joint Contracting Command – Iraq/Afghanistan (JCC-I/A) representative, the use of UXOs and IEDs by insurgents added significant time delays and costs to the project. For example, UXOs were found at the site of the future WWTP, which required coordinating with the military to clear the site prior to FluorAMEC breaking ground. After the contractor began trenching and installing pipes, insurgents planted IEDs in the trenches, which resulted in collapsed trenches and ruined pipes. Since trenching is a labor intensive (i.e. time consuming) process, having to dig the trenches again added considerable time to the overall project. Any ruined pipes necessitated contracting for additional pipe, adding to project costs and delays. The UXO problem remained a concern at the WWTP site throughout 2005, and to a lesser degree, the problem of UXOs and IEDs at the project sites continue to this day. The U.S. military throughout the duration of this project has essentially locked down the city of Falluja for security purposes. For example, in April 2007, the Marines issued an order to suspend almost all of the trench work due to concerns over IEDs implanted in the trench area. This three month security suspension on trenching impacted work on the construction of trunk lines T0, T1, T2, and T3 as well as the collection networks in Areas A, B, and C resulting in additional costs and extending overall project completion.

The project also witnessed the volatile tensions that exist between the residents of Falluja and “foreigners” (Iraqis from cities outside of Falluja). For most contracts, the U.S. government searched for qualified contractors from within Falluja. However, a contract to construct a pump station was awarded to a contractor based in Baghdad and ended with tragic results. Three of the company’s engineers were ambushed departing from a Pre-Construction Meeting in Falluja; two engineers were killed and the third was seriously wounded. The message was clear – outsiders were not welcome to work in the city – even if they were attempting to help construct a wastewater treatment system for the city’s residents.

Even local contractors and subcontractors suffered at the hands of some of the city’s residents. For example, one contractor’s senior management were kidnapped and one severely beaten. Several contractors ended up leaving the country in fear for their lives. In addition, according to Gulf Region Central (GRC) documentation, each contractor was forced to share 10% of earnings with terror groups.

Even though security has increased since mid-2007, contractors continue to face intimidation and threats; while U.S. government representatives cannot visit the project site with the frequency and duration needed to fully manage this project.

#### *Providing the Iraqis with something they did not need*

As mentioned earlier, the city of Falluja never had a comprehensive wastewater system; instead many residents relied upon the use of septic holding tanks to dispose of their sanitary waste. The project file lacked any documentation to support that the provisional Iraqi government wanted this project in the first place; rather, it appears that CPA representatives conceived of this project for the Iraqis.

In addition, according to GRD and JCC-I/A representatives, the thought of providing Falluja with a “state of the art” 21<sup>st</sup> century wastewater treatment system was impractical and unrealistic. During the 2004 time frame, emphasis needed to focus on providing essential services, such as potable water, food, electricity, and employment. While this project did employ hundreds of Falluja residents, it also provided opportunities for insurgents to plant IEDs in trenches to use against CF.



### Too many unknowns to accurately forecast project costs

The project file lacked any documentation to identify the criteria used by the CPA to determine the initial cost of this project; however, it appears the original estimate for the completion of this entire Falluja Waste Water Treatment System project was determined based upon the availability of IRRF funding at the time.

The project's initial funding level was \$32.5 million; however, this number quickly increased due to unexpected reasons, such as local subcontractor pricing for the wastewater collection system 80% higher than FluorAMEC's estimate, a new Turkey Transportation Tax, increases in worldwide shipping costs, Iraqi Social Security (12.5% increase), and increased security costs. According to ITAO documentation FluorAMEC's security costs increased in 2005 by 848%. Ultimately, because of too many unknowns, instead of completing the WWTP, pump stations, and the entire collection system for \$32.5 million, FluorAMEC was able to only complete Collection Area A for approximately \$18.7 million.

In addition, when the DO was issued in June 2004, as many as 75% of Falluja's residents had fled due to the airstrikes and armed clashes between CF and insurgents. In June 2004, there was no possible way to anticipate what the population of Falluja would be in 2015 and 2025. In reality, in June 2004, it was nearly impossible to determine the current population of Falluja. According to USACE documentation, the city of Falluja consisted of approximately 183,000 residents; while other sources listed the city's population between 250,000 – 300,000 residents. The project file lacked any documentation to identify the methodology used in determining the future population of the city. Finally, with the vastly improved security situation currently in Falluja, USACE representatives believe that the population projections will be reached far in advance of the dates set. For example, USACE representatives believe the 2015 projection of 237,400 residents will be reached by 2010. While from a reconciliation and security standpoint the population increase in Falluja is a good news story—the increased number of residents will add additional flow to the wastewater treatment system.

## **Design Change – Lagoon System to Activated Sludge System**

According to ITAO documentation, the U.S. government wanted to take advantage of the original sewer network system designed prepared by the Ghadak, the local Iraqi engineering firm, years ago. The idea was to revive the original scope of work and hire a U.S. company to complete the construction. FluorAMEC, utilizing Ghadak's previously completed master plan, recommended a wastewater stabilization pond (lagoon) system. The advantages of this system were its "simplicity, low cost and high efficiency."

The U.S. government accepted employing a lagoon system for the following reason:

*"Because of budget limitation, there is still a need to construct a sewer network system and a treatment plant with 2-stage oxidation lagoons with possible sand filters. Using this method of treatment recycling treated water can be used for irrigation purposes...The choice of a 2-stage oxidation lagoon design is expected to yield substantial cost savings over a process design."*

Prior to being terminated in September 2005, FluorAMEC developed at the 90% design level the construction plans for the WWTP. The U.S. government, even after terminating FluorAMEC, planned on utilizing the 90% design drawings. However, in August 2005, the MMPW indicated that the lagoon system option was unacceptable due to several technical and environmental reasons. The MMPW submitted a letter, which expressed reservations



about the system, such as that the treated water would not comply with international standards, there would be excessive odor, it would lead to the development of insects, and demanded a specialized staff for administration and operation. Instead, the MMPW proposed the use of sewage treatment compact units<sup>9</sup>.

The U.S. government's Sector Program Contracting Office Contractor (SPCOC) evaluated the two different sewage treatment options (i.e. lagoons vs. mechanical/activated sludge units). The SPCOC's analysis identified the advantages of both systems, addressed the concerns listed in MMPW's letter, and critically compared the two systems based on project assumptions.

### **Advantages to Both Systems**

#### **Lagoon System**

- Inexpensive to construct and operate
- Simple technology/lowest lifecycle cost
- Limited power requirements
- Easy to operate and maintain
- Acceptable effluent quality

#### **MMPW's Mechanical/Activated Sludge Unit**

- Provides a continuous high-quality effluent throughout the year. The controlled process is not very sensitive to temperature fluctuations in contrast to a lagoon system
- Steel tanks can be easily erected and relocated to a different site in the future
- Requires less land than a lagoon system.

Further, the SPCOC noted the following for the use of a lagoon system:

*"Historically, aerobic wastewater stabilization pond systems (or Lagoon system as referred within the document) have been a principle biological treatment method for a variety of wastewaters including complex industrial effluents, particularly in developing countries...This system requires no continuous monitoring nor has high power demand."*

While for the activated sludge units, the SPCOC stated the following:

*"The system includes all the conventional mechanical and instrumentation required which will result in high power demand. Additionally, the system needs to be monitored continuously by skilled personnel to ensure reliability and effluent quality."*

### **Response to MMPW's Letter of Concerns<sup>10</sup>**

Two of the MMPW's primary concerns regarding the use of a lagoon system are the following:

1. Waste water after treatment does not comply with international standards, therefore, not considered to be an efficient method; and

---

<sup>9</sup> According to GRD documentation, even though the plans provided by MMPW refer to the units as sewage treatment compact units, it only described a conventional activated sludge system. Consequently, for the remainder of the report, they will be referred to as "activated sludge" units.

<sup>10</sup> This section of the report specifically addresses two of the MMPW's concerns. To view the entire response to the MMPW's concerns, please see Appendix D.



2. The lagoon system “leads to the arising of stinking odor.”

The SPCOC provided the following responses to each concern:

1. *“The lagoon system is a reasonably efficient system used all around the world both in developed countries and undeveloped countries. Lagoon systems are used not only for domestic wastewater, but also for complex industrial effluents. The fact that every single text book on environmental engineering provides a section for properly design such systems, proves that this is a current viable and efficient solution. The proposed lagoon system has been designed following universally accepted design methods to provide a required quality effluent.”*
2. *“The odors in an anaerobic pond are the result of oxidation in the system that produces gaseous sulfide emissions ( $H_2S$ ). Recent research conducted at the Universite du Montpellier, France, using biological covers (made out of floating peat beds) resulted in a reduction of the sulfide emission rate by 84.6%. When used in combination with plants such as algae (*Juneus Effusus* L.) and iron (addition of  $Fe_3$  + as  $FeCl_3$ ) to the peat bed, the performance improved significantly to reach a  $H_2S$  removal of 95.5%. The algae also add dissolved oxygen to the system which help to oxidize the decay process. Additionally, another mitigation measures can be implemented such as planting trees around the facility and spraying the pond surface with commercially available odor-control product on a regular basis...The production of sulfides, odors, are found in all systems considered, including activated sludge systems where the mitigation measures can actually be more expensive as they should be tailored to prevent mechanical equipment failure.”*

### **Technical Comparison of the Two Systems**

The SPCOC prepared a technical comparison of the treatment systems using the following assumptions for the comparison:

- Population to be served – 180,000
- Load per capita per day – 200 liters per day (lpd)
- Design flow – 36,000 m<sup>3</sup>/day

Appendix E provides the complete technical comparison; however, Table 2 presents several key distinctions between the two systems. For example, the lagoon system requires very little power with less mechanical equipment as compared to the activated sludge unit. Power load analysis indicated that the entire lagoon system will require less than 100 kilowatt (KW) compared to more than 200-KW for each activated sludge unit. Since a single activated sludge unit can only service 50,000 people, the total estimated power demand for servicing the entire city would be close to 800-KW. According to ITAO and GRD representatives, the city of Falluja does not have a reliable power source.

In addition, the operation and maintenance costs and labor requirements for the lagoon system are insignificant when compared to the activated sludge unit. The lagoon system is designed to be operational without continuous supervision and system maintenance is limited to dredging the lagoons once a year and regular checkups of the blowers and mechanical aerators; while the activated sludge units require continuous monitoring by skilled (trained) personnel to ensure reliability and effluent quality.

Further, a testing laboratory is a must for any system to guarantee effluent quality; however, the testing program in a lagoon system can be limited to once a week, compared to daily in



an activated sludge system where unsatisfactory results may indicate poor performance of the mechanical equipment, the operation and maintenance, or both.

Finally, the capital expenditure analysis indicates that implementation of the activated sludge unit can be approximately four times the cost of implementing a lagoon system.

	<b>Lagoon System</b>	<b>Construction Sewage Treatment Compact Unit (Activated Sludge Unit)</b>
Description of Treatment System	Series of anaerobic, facultative and maturation ponds. Chlorination provided for by-pass channel and Parshall Flume for flow control.	Conventional Activated Sludge Treatment with Steel Process Unit Tanks.
Power Requirements	<100 KW (whole plant)	200 KW per unit
Operation required	None.	Qualified Trained Personnel. Continuous monitoring.
Maintenance Requirement	Low, dredge lagoon once a year	High. Continuous monitoring.
Reliability of Continuous Operation	It will work under any conditions	Requires standby or alternate power system. System will stop if equipment or instrumentation failure occurs.
ESTIMATED CONSTRUCTION COST	\$250 per m <sup>3</sup> treated	\$1,040 per m <sup>3</sup> treated

**Table 2. Comparison by the U.S. government's SPCOC of the two treatment systems**

The SPCOC concluded its evaluation stating that it is “our professional opinion that the lagoon system should be implemented as an efficient and economical solution for the City of Fallujah...the lagoon system will require no skilled personnel, little power, and little maintenance (limited to dredging the lagoons once a year) as compared” to the activated sludge unit. The lagoon system will service the entire city of Falluja through 2015 with minimum operations and maintenance (O&M) expenditures.”

*MMPW's previously agreed to a lagoon system*

In addition to utilizing Ghadak's previously completed sewer network design, Phase I of the original DO required the involvement of city engineers and ministries. The intent was to obtain the GOI's buy-in with respect to this project. Ghadak's sewer network designs were previously approved in September 2002 by the predecessor of the MMPW, the Ministry of Interior General Corporation for Water and Sewerage, Sewerage Institution. Figure 2 is Ghadak's schematic section layout for the WWTP employing the lagoon system, which was approved through the then appropriate Iraqi ministry. In addition, according to ITAO documentation, in 2005, the local ministry had approved Ghadak's design drawings.



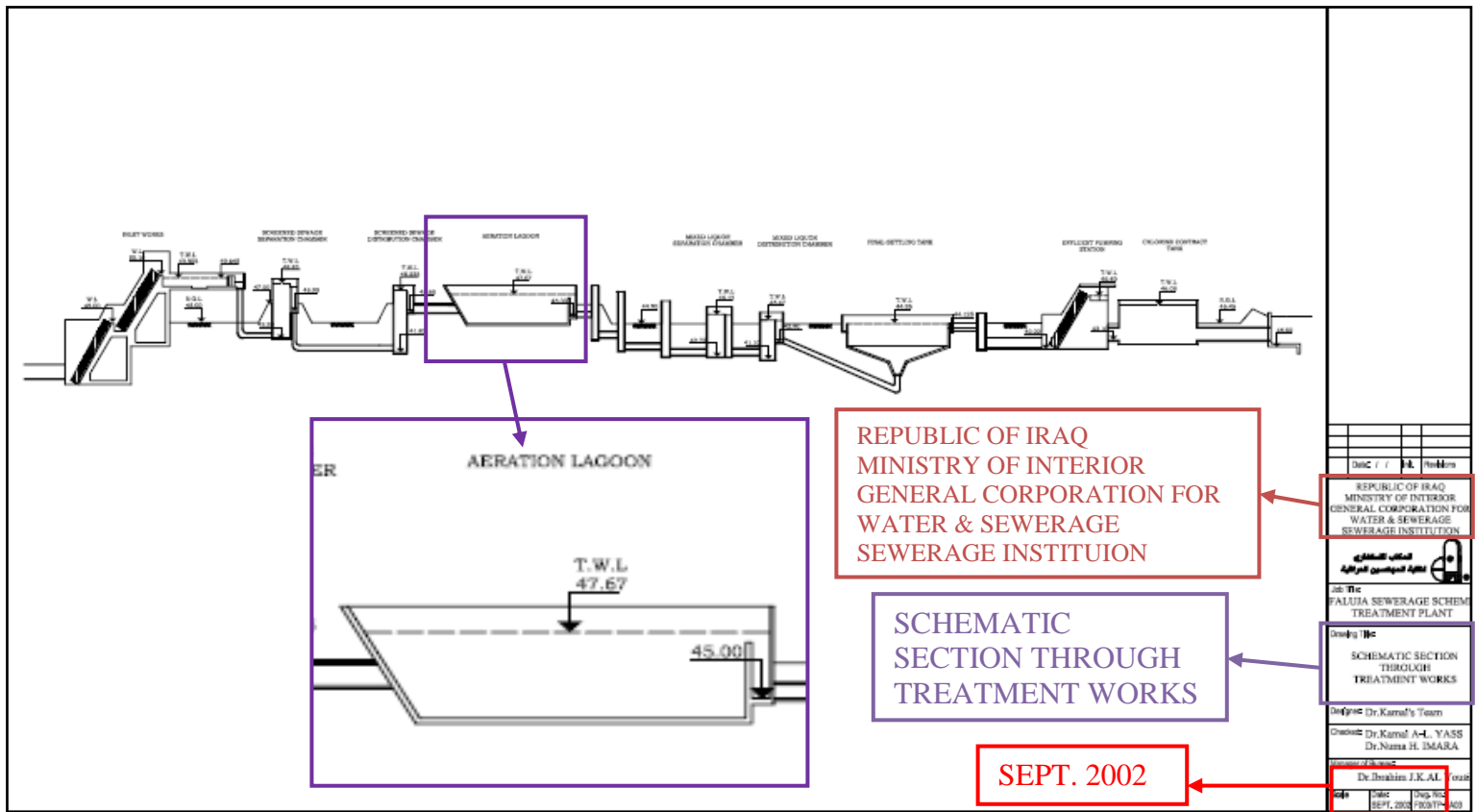


Figure 2. Ghadak's original schematic layout of the WWTP, which was designed to use a lagoon system (Figure courtesy of the USACE)

#### Reasons the MMPW objected to a lagoon system

In August 2005, the MMPW objected to the use of a lagoon system because of technical and environmental reasons. On 2 November 2005, the SPCOC completed its technical evaluation, which IRMO and GRD representatives presented the MMPW for its review. U.S. government representatives met several times with the MMPW during November 2005 in an attempt to persuade them into accepting the lagoon system. The following internal correspondence documented the reasons why U.S. government representatives wanted the MMPW to embrace the use of the lagoon system:

*"...you need to reinforce your argument for the lagoon system. Also, it would be better if put more emphasis on the construction cost versus available budget, the much lower O&M cost for the lagoon system and the fact that this is the only type of WW [waste water] treatment system that will serve all of the Fallujah population for the budget we have. The O&M issue is very important, because we have three USAID WW and W [water] treatment facilities that are not operating adequately at the present time, due to lack of ambition on the part of MMPW staff to keep them operating. They do not need more labor-intensive facilities to be responsible for, especially in Fallujah."*

Even though the SPCOC's technical evaluation thoroughly repudiated the MMPW's concerns about the lagoon system, the MMPW still refused to even consider the use of a lagoon system. U.S. government representatives stated they would be unable to modify the current design (to activated sludge units) for a reasonable price.



According to ITAO and GRD representatives, the primary reason the MMPW objected to the use of a lagoon system was their (MMPW) belief lagoon systems were for “third world countries.”

#### *Decision to change from lagoon system to activated sludge units*

According to GRD representatives, after several exhaustive meetings with the MMPW, it was clear the MMPW would not accept the use of a lagoon system. In November 2005, the IRMO Senior Consultant for Water accepted a compromise offer from the MMPW. The U.S. government agreed to eliminate the lagoon system design for the WWTP; and the MMPW would “provide 4 modular systems [activated sludge units], which would serve approximately 200,000.”

#### **Effects of Changing Design**

The decision to change the WWTP design from a lagoon system to an activated sludge system resulted in significant and long term consequences for this project. The decision to change designs directly led to increased project costs, extension of the project completion date, and monumental sustainability issues, such as the need for specialized staff to operate and perform continuous maintenance of the WWTP.

### **Funding and Contracting Issues**

From the beginning of this project, funding and contracting issues played an important role in the project slipping behind schedule.

#### *Significant Cost Growth*

The Falluja Waste Water Treatment System project was initiated in 2004 using FluorAMEC with an initial level of funding of \$32.5 million in IRRF funds. In April 2005, GRD estimated that the total cost to complete the first phase of the project (some of the system backbone, treatment plant, and collection for 12% of the city) was \$58.3 million, which was \$25.8 million greater than the available IRRF funding. Due to cost growth, IRMO decided to terminate FluorAMEC in September 2005 after completion of only Collection Area A. FluorAMEC was paid approximately \$18.7 million for its work on the original wastewater treatment system design and construction of Collection Area A.

#### *Additional Funding from Multiple Sources*

Even though IRMO realized the U.S. government did not have enough funding to complete the entire project, they “decided to proceed with the project anyway.” During the second half of 2005 and early 2006, IRMO identified additional funding to complete a portion of the project. Included in the new funding was \$18 million in DFI approved by the Minister of Finance in December 2005, along with an extension of the original DFI program to the end of 2006. The new funding also included \$9 million in CERP funds provided by Multi National Force – West (MNF-W) and additional IRRF funds that were reprogrammed within the IRRF water sector budget. By August 2006, the total funds allocated towards the project from the three funding sources were \$84.4 million.

#### *Awarding Additional Contracts*

In early 2006, GRD proposed a new execution strategy for completing the entire project that involved awarding a large number of contracts for portions of the project to Iraqi contractors who were capable of working in Falluja, which at the time was still very hostile. Eventually, a total of 45 contracts were awarded to cover engineering design support, construction, and



procurement of equipment for the project. The segmentation of the project into a large number of small and mid-sized contracts was proposed for several reasons. First, there was uncertainty on the scope of the project that could actually be constructed with the available funding, so the project was divided into a set of severable components and funding was to purchase as many components as possible. In addition, the three funding sources could not be mixed and given that each funding source varied in size, the components needed to be severable and of varying sizes. Finally, the DFI funds were authorized for only 2006, so this funding source was focused on components that could be completed in that time frame.

Even though there was rationale for dividing the project into a number of components for execution, the segmentation of the project created complex interdependencies. Some of the contracts, such as the earthwork at the WWTP, needed to be completed before construction of the plant could commence. In addition, some of the key equipment for the WWTP, pump stations, and sewer collection lines, was purchased separately from the construction contracts. As a result of these interdependencies, failure to execute certain contracts adversely impact other contracts and then eventually the project overall.

Figure 3 illustrates the complexity of this project in terms of interdependence between only the construction contracts; while also identifying the multiple types of funding sources.

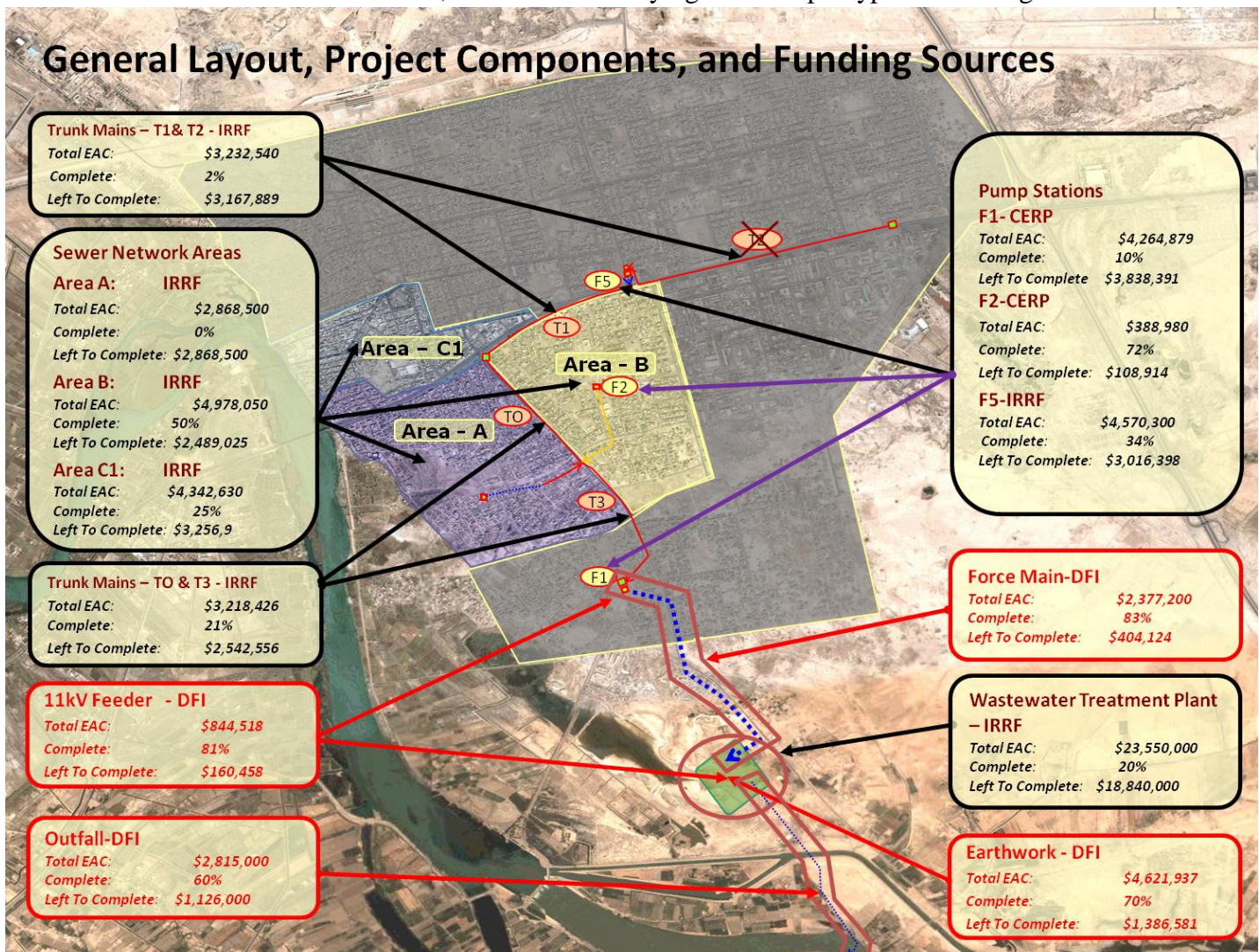


Figure 3. General project layout and funding sources system



## **DFI Contracts**

In support the Falluja Waste Water Treatment System project, the MMPW committed \$18 million in DFI funds. Eleven separate contracts, such as providing 11 kilovolt (kV) power feeder lines from a local substation to the WWTP and pump station and constructing the Force Main from Pump Station F1 to the WWTP as well as providing the procurement of critical equipment, were awarded between February and August 2006 in the amount of approximately \$15.6 million. ITAO documentation identified the DFI contracts as “key contracts whose completion will impact the entire project.”

According to ITAO, GRD, and JCC-I/A representatives, the factor that had the greatest impact on this project was the lack of payments made by the Ministry of Finance (MoF) for DFI contracts. ITAO representatives stated that prior to May 2006, the U.S. government had administered a large number of DFI funded contracts and was given sole responsibility for validating the work completed and payments were routinely authorized by the MoF without delay. However, in May 2006, the permanent Iraqi government took office and the new MoF administration imposed new requirements for processing of DFI payments that were in a constant state of flux and were never really clearly defined or finalized.

According to ITAO, GRD, and JCC-I/A representatives, by early August 2006, the DFI contracts were encountering serious problems. Specifically, the MoF was not paying DFI contractors for work performed. The MoF rejected invoice packages submitted for payment of DFI contractors. ITAO, GRD, and JCC-I/A representatives stated that no matter the content or presentation of the DFI contractor invoice packages, the MoF continued to refuse payment; further frustration stemmed from the fact the MoF would not identify exactly what was required for payments. This in turn had a direct effect upon project status. For example, in October 2006, USACE GRC Camp Falluja Resident Office<sup>11</sup> representatives reported that “2 more contractors in Falluja that have stopped work” because they had not been paid.

By early April 2007, there were outstanding contractor invoices for the four construction DFI contracts in excess of \$3 million. On 18 April 2007, at the urging of the U.S. government, the Iraqi Prime Minister issued a letter to the Minister of Finance in an attempt to resolve the ongoing DFI issues; according to ITAO documentation, the Prime Minister “directed the Minister of Finance to complete the payments.” However, the problem with DFI payments continued. On 31 December 2007, four DFI construction contracts had outstanding balances in the amount of \$2,183,732, including five submitted invoices that were over a year old. Appendix F provides the details of all four DFI construction contracts, including each individual invoice, the date each invoice was submitted, the amount paid, and amount outstanding.

### **Contract DFIWAT-06-C-0023 Force Main**

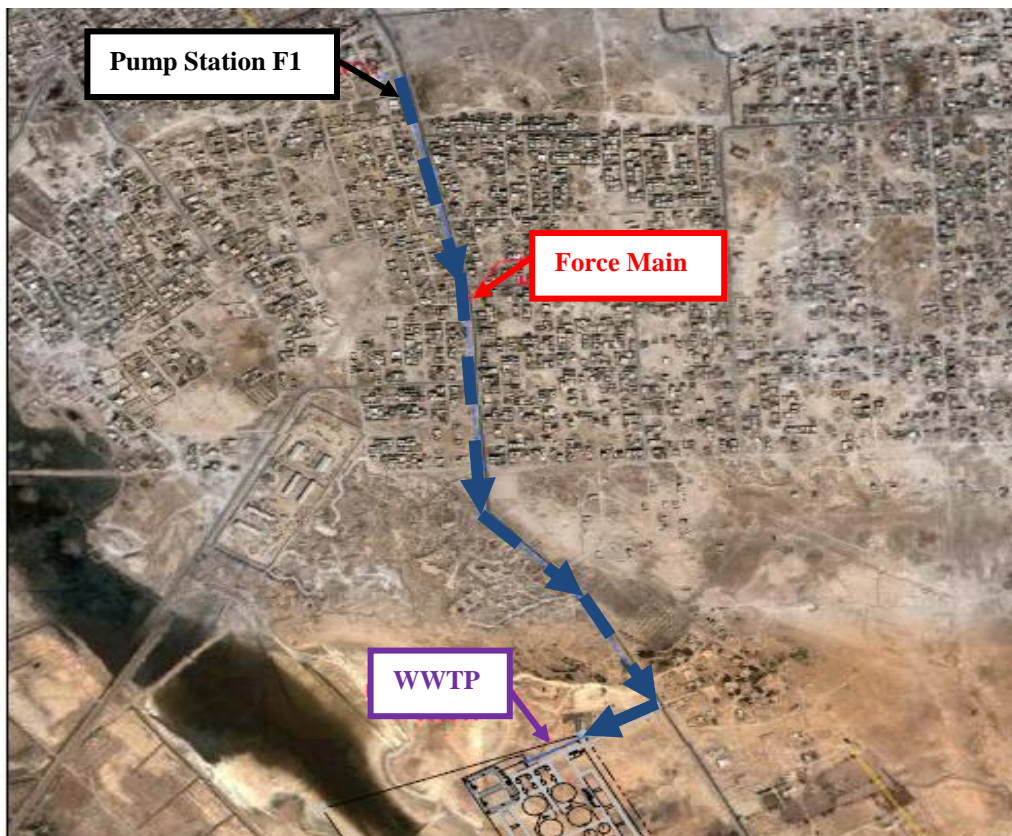
DFI funded Contract DFIWAT-06-C-0023 was awarded to a local contractor<sup>12</sup> on 8 July 2006 for the amount of \$2,439,700. The objective of this contract was to provide a fully operational Force Main from the F1 Pump Station to the WWTP (Figure 4). The contract required the contractor to complete the project within 120 days of the issuance of the notice to proceed, which was issued 29 August 2006.

---

<sup>11</sup> The Camp Falluja Resident Office is the local field office for the USACE GRC responsible for managing projects within its area.

<sup>12</sup> Due to the still volatile security situation in Falluja, SIGIR will not address any of the contractors or subcontractors currently working at a project site by name.





**Figure 4. Location of Force Main (between the Pump Station F1 and WWTP)  
(Figure courtesy of the USACE)**

According to Camp Falluja Resident Office documentation, this project was constructed without delay and has been fully flow tested and hydrostatically tested. In addition, the contractor submitted his close-out package, including as-built drawings, test results, hydro-test results, equipment listings, and spare parts. The Camp Falluja Resident Office has identified this contractor as “one of the best we have experienced here in Fallujah to date.”

However, according to Camp Falluja Resident Office documentation, invoices submitted for payment have consistently not been paid by the MoF. For example, as of 4 August 2008, the contractor had completed the project, yet had an outstanding balance with the MoF in the amount of \$1,328,875 (for invoices from as far back as November 2006). Even when the MoF made a payment to the contractor, it often took several months. For example, a progress payment in the amount of \$235,748 was made by the MoF seven months after the invoice was submitted.

This contractor has notified the USACE that “he will not allow beneficial occupancy until he has received the outstanding balance due to him through DFI.” All manholes and valve boxes are now locked down, preventing its use until such time as full and final payment is made (Site Photos 3-5).

This pipeline is a critical main-line component of the system because without its use, wastewater will not flow from the Pump Station F1 to the WWTP. Ultimately, if this problem is not addressed, wastewater will back up into residents’ houses causing damage and odor.





**Site Photo 3. Force Main manhole locked by contractor over non-payment of DFI contract  
(Photo courtesy of the USACE)**



**Site Photo 4. Force Main valve box locked by contractor  
(Photos courtesy of the USACE)**



**Site Photo 5. Close up of Site Photo 4**



### Treasury Attaché

At the request of ITAO, the Treasury Attaché's office became involved in the DFI payment issue with the MoF. Specifically, the Treasury Attaché's office was asked to provide assistance in getting the DFI contractors paid their outstanding balances. According to Treasury Attaché representatives, the primary reason the invoices were not being paid was the U.S. government did not submit the correct documentation. A new Minister of Finance was appointed in 2006, and he wanted to make sure any payments were made for work actually performed.

In an email, a Treasury Attaché representative advised representatives from ITAO, GRD, and JCC-I/A what was necessary to elicit a payment for outstanding DFI balances:

*"What I need from you is simply the following:  
Get a simple statement signed by someone in charge at the MMPW or MoWR [Ministry of Water Resources] to say the request #2735 for \$651,000 represent the final payment, or for 75% of the work, 50% or whatever this payment reflect of the work performed. This statement does not have to be signed by the minister or his deputy. Someone who can acknowledge the existence of the relevant project should be sufficient."*

When advised of this statement, ITAO, GRD, and JCC-I/A representatives all categorically rejected the notion that all the MoF required was someone to "acknowledge the existence of the relevant project." Specifically, ITAO, GRD, and JCC-I/A representatives stated they submitted the invoice packages multiple times in multiple fashions without success. The ITAO and Camp Falluja Resident Office representatives identified the spreadsheet located in Appendix F and noted that there appeared to be no rhyme or reason to the MoF's payments. For example, for the Force Main contract, the first and fifth invoices were paid; while the second, third, fourth, and sixth invoices have gone unpaid.

On 25 August 2008, representatives from ITAO and the Treasury Attaché hand delivered invoices for five of the six contracts with outstanding balances directly to the MoF's office. According to the Treasury Attaché representative, these invoices had the required information for the MoF (i.e. signed acknowledging the existence of the projects) and the Minister approved the invoices for payment. However, even after the Minister approves an invoice, payment is not immediate. For example, even though the Minister approved the invoices on 25 August 2008, as of 2 October 2008, ITAO representatives confirmed that none of the contractors has yet to receive payment.

### Status of Falluja Waste Water Treatment System DFI Contracts

As a result of the lack of payments, some of the DFI funded construction contractors stopped work while some of the contractors responsible for equipment procurement refused to execute their contracts. The subsequent work stoppages and lack of equipment impacted progress on the IRRF and CERP funded contracts.

According to ITAO documentation, by mid-2007, the situation with the DFI-funded contracts became untenable, and in October 2007, ITAO formally agreed to buyout most of the DFI contracts with IRRF. Some of the DFI contracts associated with the CERP funded construction contracts would eventually be bought out with CERP. In October 2007, GRD and JCC-I/A were directed to terminate the DFI contracts and award new contracts for the remaining work using either CERP or IRRF funds. JCC-I/A was fortuitously granted renewed administrative authority for DFI funded contracts at the end of 2007, which allowed them to terminate the DFI contracts. The previous DFI administrative authority had expired at the end of 2006, which also complicated the DFI payment issue in 2007 because



from a legal standpoint, the U.S. government had no administrative authority to even validate work completed or process payment on DFI contracts.

The DFI contracts were terminated in December 2007. ITAO decided to use additional IRRF to fund the work not completed under the original DFI funded contracts. Re-awarding the work is on-going and not complete. The re-awarding of work has been slowed because of the large number of contracts requiring re-award (contract re-awards were required in the collection system also). Slow progress has been due to the lack of qualified contractors who can work in politically sensitive Falluja. To ensure contractors would be used who would be accepted in Falluja, justification documents were required, which led to additional delays.

As of 4 August 2008, six DFI contracts had outstanding balances due its contractors. One contract, to provide clarifiers for the WWTP, had an outstanding balance in the amount of \$802,896. The U.S. government decided to issue a modification to an existing IRRF funded contract to pay this outstanding balance; therefore, this contract is no longer classified in the "outstanding balance" category. Consequently, there are currently five DFI contracts with a total outstanding balance of \$2,331,532. Appendix G provides the current list of DFI funded contracts with outstanding balances.

#### *Contracting in a Combat Zone*

According to Camp Falluja Resident Office representatives, contracting has been one of the most critical aspects of the entire program that seriously impacted the completion of work. Specifically, contracting was substantially delayed "by rigid application of USG FAR [U.S. Government Federal Acquisition Regulation]," which demanded that any sole-source contract action must satisfy anti-competition regulations that apply in the U.S. For example, part of the FAR process is satisfying a Justification and Approval (J&A) review by the Legal Department of the Principal Assistant Responsible for Contracting (PARC). Camp Falluja Resident Office representatives stated the case of the DFI contract for Earthworks at the WWTP. The execution strategy after the decision to buyout the DFI contracts was to award a single, sole source modification to one of the largest construction contractors working on the project. The rationale was a modification would mean no new solicitation, no delay, and work could continue to allow the WWTP to proceed. After completion of the negotiations for the sole source modification with the contractor, the contracting action to award the sole source modification was transferred between JCC-I/A and GRC five times. In July 2008, the USACE contracting authority (the PARC) rejected the justification for a sole source modification. This decision was going to require the drafting of a new solicitation (including accurate site measurement of completed work and outstanding work still to do), contract award, and a third contractor come into the field of play. Camp Falluja Resident Office representatives stated it would "take at least another 3 months but likely longer based upon historical performance." Fortunately, this issue was resolved, but only after some further time delay.

Camp Falluja Resident Office representatives feel the "FAR must be moderated in a less rigid way to meet the 'special demands' of working not only in a foreign and de-regulated country but also in a war zone."



## Indecision by U.S. Government Officials

As mentioned in the previous section, in May 2006, the permanent Iraqi government took office and the new Minister of Finance imposed new requirements for the processing of DFI payments. According to ITAO, GRD, and JCC-I/A representatives, DFI funded contract payments were continuously delayed and/or rejected without any explanation. By August 2006, the U.S. government realized the delinquent DFI payments would continue to present significant obstacles to the completion of the overall project. Since the segmentation of the overall project into multiple contracts created complex interdependencies between contracts, the delay of progress of DFI funded contracts would adversely affect the progress of the IRRF and CERP funded contracts.

In August 2006, the U.S. government first considered buying out the DFI funded contracts with IRRF. Over the next year, the IRMO, GRD, and JCC-I/A worked continuously to prompt the MoF to pay the outstanding DFI funded contract invoices; while at the same time, internal discussions centered on whether DFI contracts could be bought out using IRRF; specifically, whether it was possible for the U.S. government to pay the outstanding DFI payments using IRRF. In late August 2006, the JCC-I/A Judge Advocate stated the U.S. government “cannot directly use IRRF to pay for DFI contracts...”

From August 2006 through March 2007, meetings were held, discussing several different proposals regarding funding possibilities, alternatives, and options for the overall system; specifically, the need for additional IRRF funding, whether to construct a two or four train<sup>13</sup> WWTP, and the collection areas to be included in the overall project. However, no final decision on issues was made. By April 2007, the Senior Consultant for Water stated a decision was needed at least on funding because “we have punted this project long enough;” yet ITAO, GRD, and JCC-I/A could not identify a path forward to complete this project. Between January 2007 and October 2007, at least 20 separate briefing charts, Information Memorandums, decision briefs, and emails were created to provide multiple alternatives with regards to funding and a path forward. For example, a “Decision Brief,” prepared by GRD on 21 July 2007, identified all the problems encountered, provided four potential solutions/courses of action, and recommended option 2A (downsize the WWTP by 50% and build three collection systems). Yet, as of 3 August 2007, a decision still had not been made, and the ITAO Senior Consultant for Water emailed the ITAO Director of Operations stating that “the decision in is fact long overdue and I don’t think it should languish any longer.” Between August 2007 and September 2007, the ITAO Senior Consultant for Water continued to request a decision from the ITAO Director of Operations with emails, such as the following:

*“have you made a final decision on the Fallujah project?”*

*“we need to get a final decision.”*

*“I don’t want to be a broken record, but GRD really needs a final decision on the way ahead with Fallujah.”*

---

<sup>13</sup> Often multiple water and sewer treatment plants process in a series, which is referred to as “trains.” These trains are generally made up of several different mechanical or chemical processes to form a “train of processes” that treat the water and sewage in stages. The packaged plants provided by the MMPW were pre-designed so as to have all the processes needed to form a complete treatment train. The benefits are when more treatment capacity is needed, a new train can be added and also having multiple treatment trains helps prevent total shut-down of treatment facilities during routine maintenance and equipment failures.



On 2 November 2007, after more than 15 months of meetings, briefing charts, official memorandums, and countless email exchanges, the ITAO Senior Consultant for Water sent a letter to the MMPW informing them of the final decision on funding and path forward (Figure 5). Specifically, the U.S. government decided to do the following:

*“the U.S. Government has decided to terminate the outstanding DFI contracts for this project and complete the remaining work using U.S. Government funds...Therefore, the scope of the final project will include:*

1. Treatment plant with four treatment trains
2. Outfall
3. Force main and T0, T1, and T3 trunklines
4. Power connections to treatment plant and pump stations
5. F1, F2, and F5 pump stations
6. Collection systems in Areas A, B, and C1”

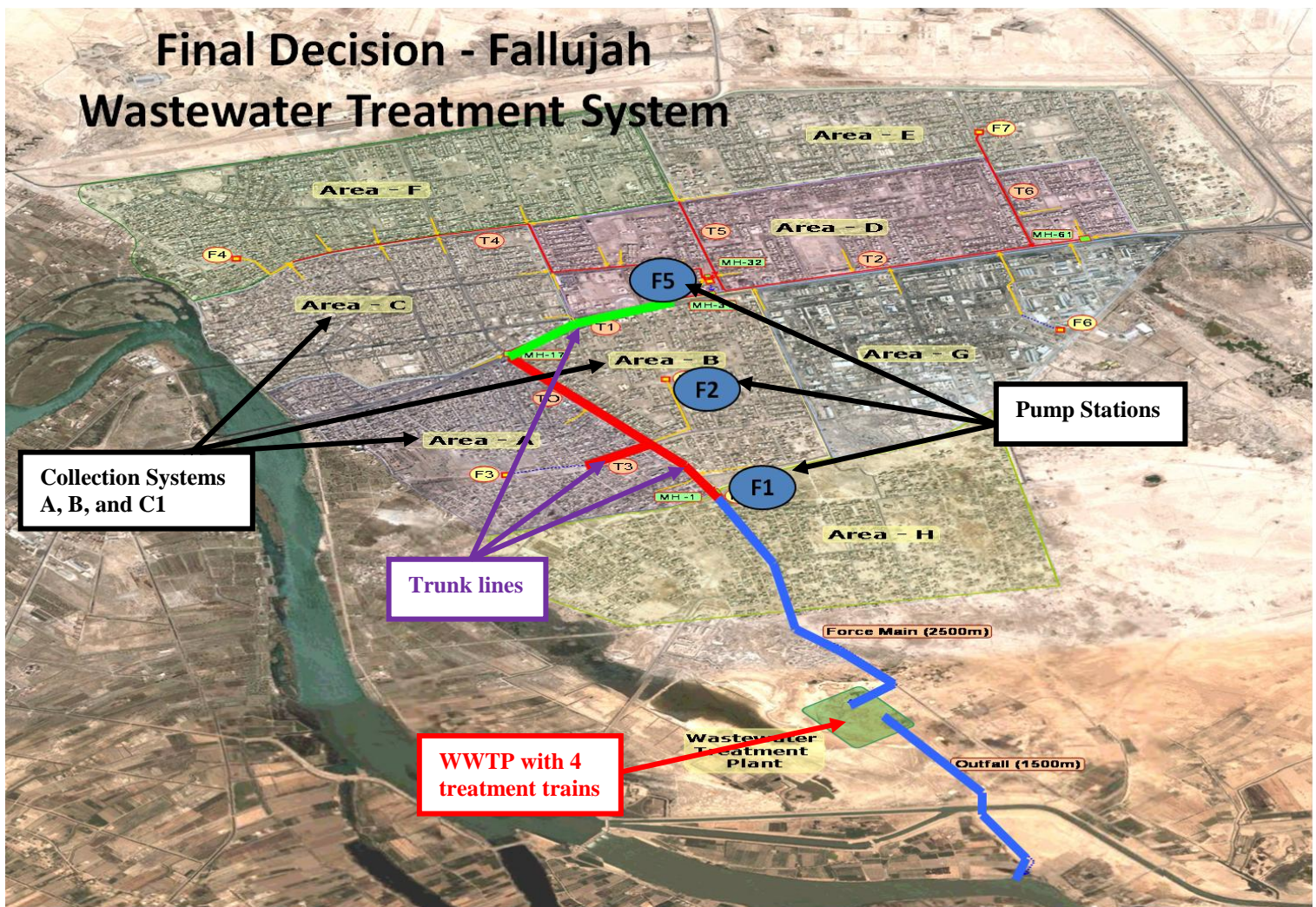


Figure 5. Final decision on construction work to be completed



## **Limited Contractor Pool and the Resulting Quality Issues**

The city of Falluja is self-protecting; each resident is aware and wary of any outsider entering the city. As mentioned earlier, when the U.S. government attempted to award a single contract to a contractor from outside of Falluja, it was met with tragic results. As a result, the U.S. government was left with few options other than award all of the contracts to local contractors and subcontractors. However, as noted in the U.S. government's original DO justification, the city of Falluja had never had a comprehensive sewer system. Since the city was unfamiliar with a comprehensive sewer system, it was unrealistic to expect to find local contractors with the capabilities to adequately build such a system.

According to Camp Falluja Resident Office representatives, there has been "continuous quality issues due to...cheap and inexperienced subcontractors and general inexperience on structures of this size and complexity." Camp Falluja Resident Office representatives documented several quality problems associated with inexperienced contractors/subcontractors, such as the following:

- cold joints in the wet well of Pump Station F2 (which could allow the entry of water)
- incorrectly placed water stops
- puddle flanges "manufactured" on site (rather than procured)
- leaking expansion joints
- unacceptable construction joints

The continuous quality issues are time consuming for both the Camp Falluja Resident Office representatives and the overall project. The Camp Falluja Resident Office representatives, upon identifying quality issues, meet with the contractors to discuss the issue and potential solutions. For example, Camp Falluja Resident Office representatives required a contractor to chip out and repair the unacceptable construction joints. In instances where the contractor refuses, Stop Work Orders must be issued until a resolution is reached. This extensive process takes away valuable time from the Camp Falluja Resident Office representatives for monitoring the completion of the remaining project. For the contractors, forward momentum is lost each time a significant quality issue is identified requiring corrective action.

In addition, Camp Falluja Resident Office representatives stated that most contractors and subcontractors associated with this project do not have the required technical capabilities to perform complex and dangerous work, such as excavation and shoring. This has placed a great burden upon the Camp Falluja Resident Office representatives to mentor and monitor the safe use of equipment and safety practices unknown to the contractors and subcontractors of Falluja.

## **Workplace Safety Issues at the Project Sites**

The use of local contractors and subcontractors for this project has resulted in continual safety issues and problems for the Camp Falluja Resident Office, who is responsible for ensuring that the contractors employ safe construction practices. According to Camp Falluja Resident Office representatives, safety issues continue to take up an inordinate amount of time. Specifically, Camp Falluja Resident Office representatives often encounter ongoing resistance by the contractors to provide safe working scaffolding and formwork, trenching, and safe working systems. A Camp Falluja Resident Office representative stated that safety "continues to be a constant review to ensure we are dragging the contractors back onto a



safe working line.” The Camp Falluja Resident Office representative feels that safety is a “constant worry and a constant fight,” which he finds “excessively grueling.”

During the course of this project, there have been four (4) fatalities due to construction activities. The first fatality was due to a trench collapse in the deep trench of the main trunk line. The shoring was set too deep below the ground level, with trench side walls above the trench box inadequately sloped back. The soil had been previously disturbed during the laying of 11-kV feeders, which made it even more unstable. With the ground water in Falluja being perched, water was in the bottom of the trench during pipe installation. The sides collapsed over the top of and inside the trench box, killing one worker and partially burying another who escaped unharmed. According to Camp Falluja Resident Office documentation, the contractor had previously been warned and censured over his shoring operation, but apparently the contractor refused to practice safe shoring operations. After the fatality, the contractor was terminated for default on this contract.

The second fatality also occurred as a result of a trench collapse. According to Camp Falluja Resident Office representatives, prior to the fatality, they had closed down the contractor for safety concerns many times. Camp Falluja Resident Office representatives forced the contractor to revisit his work plans and Accident Prevention Plan, train his staff, and appoint competent people. However, according to Camp Falluja Resident Office representatives, the contractor did not have the “intent” to do the work safely. The contractor’s site safety staff and site supervision were so lax that workers were allowed to walk and work outside of the shoring systems, which resulted in the death of one worker and the injury of another. After the fatality, the contractor was terminated for default.

The third fatality was the result of a lifting accident on a deep trunk main where one of the heavy cross-brace struts of the shoring system was being moved off site. The crane driver, who was an owner-operator-subcontractor, was lifting the load erratically. At the same time, the crane driver’s brother, who was not authorized to be there, was standing near the crane cab talking on his cell phone. The load struck the 17 year old brother on the back of the head, and the crane driver panicked, thereby dropping the load onto his younger brother. The boy died of internal bleeding on the way to the hospital. Prior to this accident, the crane driver attended Camp Falluja Resident Office staffed safety training meetings; however, according to Camp Falluja Resident Office representatives, he expressed little interest. The contractor, who attempted to maintain a pedestrian free site by asking the younger brother to leave the site (he refused), was not terminated.

#### Contract W91GY1-06-C-0048 Collection System A

Prior to being terminated in September 2005, FluorAMEC completed a portion of Collection System A; however, as mentioned earlier in this report, at the time Collection System A was being completed by FluorAMEC, security was almost impossible to facilitate any level of site management. The quality of the work performed by FluorAMEC was called into question when issues were found, such as manholes with no concrete base slab and pipe work running uphill.

The IRRF-funded Contract W91GY1-06-C-0048 was awarded to a local contractor on 9 September 2006 for the amount of \$2,868,500. The objective of this contract was to completely evaluate the current status of the Collection System A and identify the repairs needed to make it a complete and functional collection system.

The fourth fatality occurred within Collection System A; yet, this fatality was not the responsibility of the contractor. While the contractor was working on this particular collection system, many Falluja residents were illegally tapping into the new sewer trunk



lines (to allow sewage to flow from their homes to the sewer line). However, the trunk lines were not ready to receive flow; the completion of the pump stations and wastewater treatment facilities were required to service these trunk lines. As the contractor neared completion of Collection System A, he attempted to flow test pipes and flood test manholes. Due to the illegal sewage flow into his network, the contractor placed pipe plugs into several pipe runs being tested to enable him to work. This resulted in sewage backing up into the houses where illegal taps had been made. According to Camp Falluja Resident Office representatives, one family sent their 16 year old son out early one morning to remove the pipe plug and free the sewage flow from the family's house. Unfortunately, as he removed the pipe plug he was overcome by sewer fumes and died of asphyxiation.

#### Effects of Fatalities upon Schedule and Costs

Aside from the unfortunate loss of lives, the fatalities had direct impacts upon the overall project's schedule and costs. First of all, as with any work place fatality, the job sites were shutdown while accident investigations were made and safety measures and practices were reviewed (via Stop Work Orders). The decisions the Camp Falluja Resident Office had to make were often times very complex. For example, when discussing whether to terminate a contractor or rescind a previously issued Stop Work Order, a Camp Falluja Resident Office email stated the following:

*"I have reviewed the complex situation, and have determined the best way forward (in my opinion, and open to dispute, discussion or rejection) is to persevere with this contractor for the following reasons and justifications:*

- 1. T4D [termination for default] will not ensure we get a better contractor next time around.*
- 2. This contractor does, I truly believe, have an honest intent.*
- 3. He is also appointing stronger management on site to oversee the work.*
- 4. He is learning (albeit slowly) that safety does matter, and that we shall not allow him to put life at risk.*
- 5. He has promised to remove rogue elements that refuse to comply with our safety instructions from site.*

*The USACE Fallujah project team has worked long and hard to get to where we are now, and to T4D and re-appoint, we may be creating an even more dangerous situation for the Fallujah workforce in future...Project schedule...this part of the project is a critical component of the system, and must be completed by 30 June 08 to allow the system to be put into operation. Contractual delays will void this requirement...Cost increases are likely when appointing a new contractor."*

While the Camp Falluja Resident Office did lift the Stop Work Order for this contractor, two other contractors were terminated for default as a result of workplace fatalities. However, terminating each contract led to significant time delays. For example, the U.S. government issued a suspension of work on 15 September 2007 to the Collection System B contractor after the trench collapse fatality; yet the contractor "failed to cure the conditions endangering performance." On 25 January 2008, the U.S. government terminated the contractor because the "Government has no confidence that this contract will be completed without another serious safety violation or death." According to Camp Falluja Resident Office documentation, the settlement of the terminated contract has been prolonged due to contractor inflexibility. Specifically, "unjustified settlement claims and lack of cooperation regarding the return of government furnished equipment" delayed the settlement. The termination modification and settlement was completed on 26 August 2008, almost an entire



year after the incident leading to the contractor's ultimate termination. This contract was re-awarded on 30 September 2008, more than a year after the project site fatality and eight months after the contract was originally terminated.

For example, the 28 February 2007 fatality on the Trunk Line T1-T2 and repeated "failure to follow construction safety, dewatering, and trench protection," caused the U.S. government to terminate the contractor on 8 August 2007. According to GRC documentation, "during negotiations to settle the terminated contract, [the contractor] made unreasonable claims needlessly delaying the procedure," which resulted in the termination modification and settlement not being reached until 15 July 2008. This contract was re-awarded on 28 August 2008, more than a year after the contract was originally terminated.

## **Current Project Design and Specifications**

As mentioned earlier in this report, the Falluja WWTP originally was designed using a lagoon system; however, due to the MMPW's refusal to even consider its usage, the U.S. government agreed to re-design the WWTP using activated sludge units. In February 2006, Contract W91GY1-06-M-0004 for \$497,118 was awarded to re-design the WWTP, which required the contractor to provide "consulting engineering services" for the collection system, WWTP, pump stations, and force main pipe.

For the 100% designs of the WWTP and pump stations, Ghadak submitted drawings, consisting of civil and site utilities, architectural, electrical, mechanical, plumbing, and structural.

According to ITAO and Camp Falluja Resident Office representatives, the original design drawings for both the WWTP and pump stations were "technically inadequate," which required the U.S. government contract with Washington International/Black and Veatch (WI/BV) to complete the construction package. For example, Ghadak's design submittal for the WWTP had "many technical issues" requiring WI/BV to develop detailed designs for chlorination system, scrubber, polymer slab, and polymer system design.

For the pump stations, a peer design review was required to bring the pump station "up to international safety and engineering code compliance...provide maintenance walkways to pump shaft bearings for maintenance access, improved air supply to the wet well, and reduced structural elements deemed unnecessary."

In addition, the 2006 designs for all three collection systems were technically inadequate. As mentioned earlier, security was a major concern prior to mid-2007. Creating the designs for the collection systems required detailed surveys of the very neighborhoods where intense fighting was still ongoing. According to Camp Falluja Resident Office documentation, the Iraqi design engineer was unable to complete site surveys due to security fears; instead the design engineer asked the MMPW for its most current neighborhood plans (which were from 2002). Since the MMPW's plans, the city had radically changed, with some new houses built and other areas demolished.

The design package also included the mechanical design featuring flow diagrams, system layouts, electrical distribution system design including flow diagrams; as well as an overall conceptual site plan, which identified the location of all significant new construction specifically for the WWTP, such as the inlet tanks, surge storage tanks, aeration tanks, clarifiers, and associated on-site facilities.



The WWTP is divided into 4 treatment trains, each having the identical capacity of 10,000m<sup>3</sup>/day (average daily flow). The treatment trains are a package plant system provided by the MMPW and adapted to this project by the U.S. government's SPCOC. The pre-packaged plants utilized conventional treatment processes, such as the following:

- inlet tank with inlet raw water pumps
- manual bar screen and mechanical fine screen
- grit and oil removal
- aeration system with blowers and diffusers
- final settling
- chlorination
- effluent pumping
- sludge thickening and disposal

The design later included surge storage basin capacity to the layout, along with a bypass system, to accommodate anticipated influent wastewater flows that exceed the combined ability of the packaged treatment system. Sludge will be thickened and placed on the sludge drying beds, after which it will need to be removed and properly disposed. The treated wastewater will then be discharged directly into the Euphrates River. Figure 6 provides an illustration of the WWTP and its components/processes.

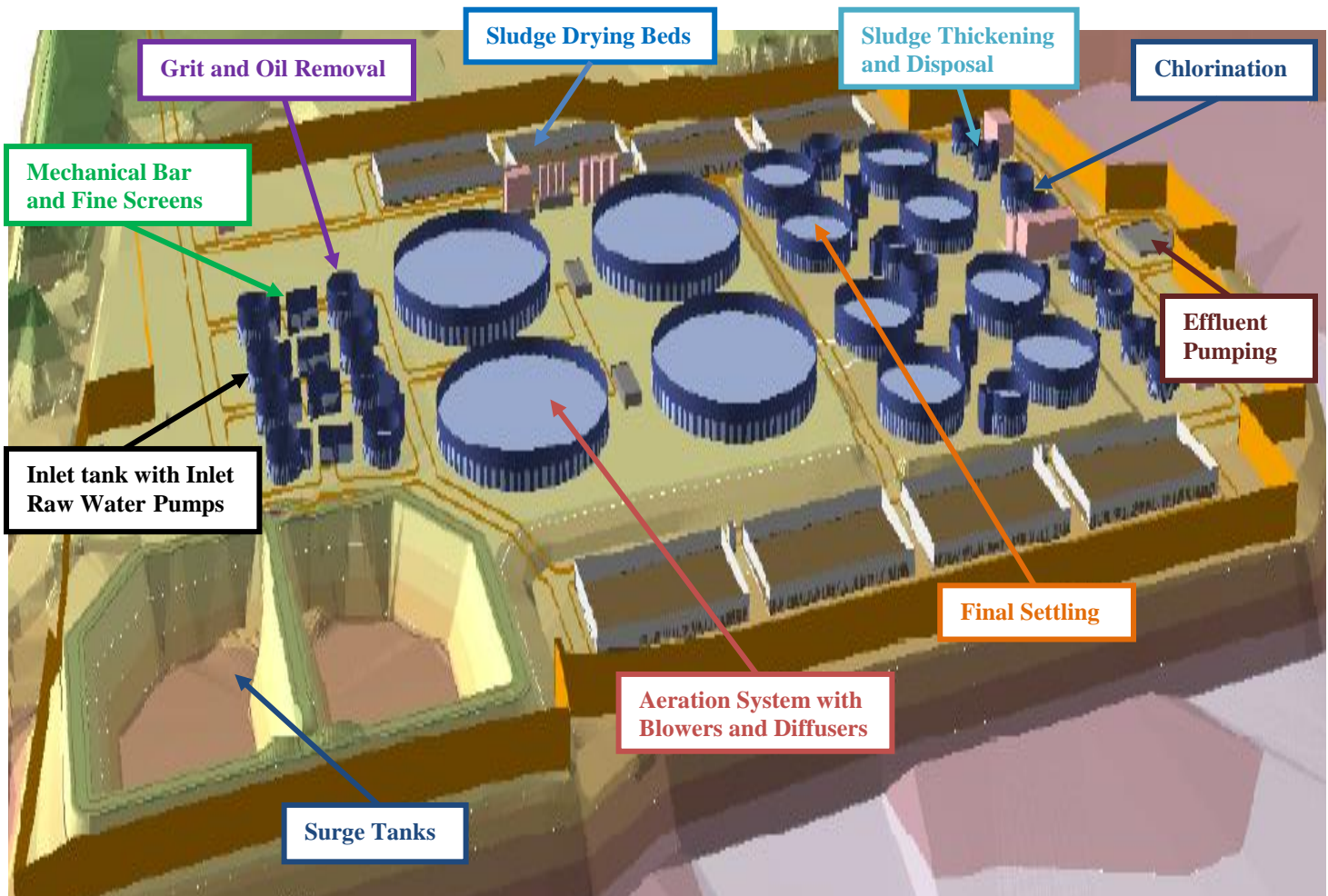


Figure 6. General site arrangement of the WWTP



### Odor Control

Odor from a WWTP is caused by the release of hydrogen sulfide gases into the atmosphere. These gases can be swept by winds to nearby populated areas and cause complaints from residents. In a mechanical (activated sludge) WWTP, the problem areas for odors are generally at the headworks, the sludge digestors, the sludge drying processes, and the surge storage tanks.

One of the primary reasons the MMPW rejected the use of the original design of a lagoon system was that it would lead to the “arising of stinking odor.” However, the MMPW’s design for the WWTP using the activate sludge units did not provide for odor control. Specifically, there are no odor control facilities furnished with this plant. According to Camp Falluja Resident Office representatives, the surge tank, inlet tank, and inlet works will generate undesirable odors. In addition, the area near the WWTP is fast developing into a residential area (Site Photo 6 and Figure 7), and it is anticipated that there will be complaints from the residents about the odor. Also, these residents may become angry because they are not part of the collection system. Consequently, these residents will see and smell the WWTP, yet will not benefit at all from it. Further, the residents near pump stations F1 and F5 may experience a “big stink” once the plant goes into operation. During the design review process, the lack of odor control facilities was identified; however, the potential solutions to the odor problem at the WWTP and pump stations are expensive, ranging from at least \$1 million to \$8 million. Due to project funding constraints, this was not remedied.





**Site Photo 6. View of new houses near the WWTP sludge drying beds, where a significant odor will occur  
(photo taken from sludge drying beds)**



**Figure 7. Portion of the WWTP (sludge drying bed area)**

### **Future Expansion Option for the MMPW**

The original 2004 DO required providing a sewer network system for the entire city of Falluja, including all eight collection areas. Due to variety of reasons previously mentioned, including funding limitations and security problems, the U.S. government decided to only fund three collections systems. Part of the “reach back” effort of the WI/BV contract is to provide detailed and accurate designs for the remaining collection systems to the MMPW which will be responsible for funding and completing the remainder of the wastewater treatment system. The IRRF funded WWTP, when completed, will consist of four trains, which will be able to handle the added flow from eight collection areas.

### **Conclusion**

Although the project had to be redesigned two separate times at significant additional cost to the U.S. government, the contract’s design and specifications were eventually revised to be specific enough to construct the WWTP and associated facilities. The revised design has taken into consideration the sequencing of work and the relationship to other contract work. Based upon our review of the revised drawings and specifications, they appear to be



complete and consistent with the contract's requirements. The revised drawings were adequately designed prior to construction. However, it must be noted that the primary concern of the MMPW was the odor produced from a lagoon system was not addressed by the original design of the WWTP with the activated sludge units. During the design review process, this was identified; however, due to project funding constraints, it was not remedied. Consequently, the residents of Falluja (many of whom will not have access to the wastewater treatment system) may be subjected to significant odors emitted from the pump stations and the WWTP.

## Site Assessment

On 23 August 2008 and 22 September 2008, SIGIR performed on-site assessments of the Falluja Waste Water Treatment System. Specifically, SIGIR visited and evaluated the WWTP (including Earthworks) and Pump Station F1. During both site visits, we were accompanied by Camp Falluja Resident Office representatives. Due to security concerns, on each occasion we performed an expedited assessment. The time allotted for the WWTP and the pump station was approximately one hour and 30 minutes, respectively; therefore, a complete review of all work completed was not possible.

On each site visit, we observed contractor personnel working at both construction sites.

### **Waste Water Treatment Plant**

#### **Contract DFIWAT-06-C-0027 WWTP Earthworks**

The DFI funded Contract DFIWAT-06-C-0027 was awarded to a local contractor on 26 July 2006 in the amount of \$4,621,937. The objective of the contract was to prepare the site of the new Falluja WWTP. The contract required the contractor complete the project within 60 days of the Notice to Proceed (NTP), which was issued on 19 August 2006. According to GRC documentation, Phases I and II of this contract were "substantially completed before DFI failure-related non-payment of invoices forced the contractor to stop working." After the U.S. government terminated the DFI contracts in late 2007, Earthwork for Phases III and IV was awarded using IRRF.

At the time of our site visits, the contractor had completed approximately 70% of the contract. The WWTP appeared to be filled to a consistent elevation of several meters above the adjacent dry lake bed, which should make the facility safe from potential flooding. The earth fill was consistent and appeared to be well compacted. According to Camp Falluja Resident Office representatives, the contractor used a "sheepsfoot" type roller to compact the fill. While the rough grading was complete, the finish grading activities had not yet begun. Site Photo 7 provides an example of the contractor's work, specifically the aeration tank subgrade.





**Site Photo 7. Aeration tank subgrade**

**Contract W91GY1-06-C-0047 WWTP**

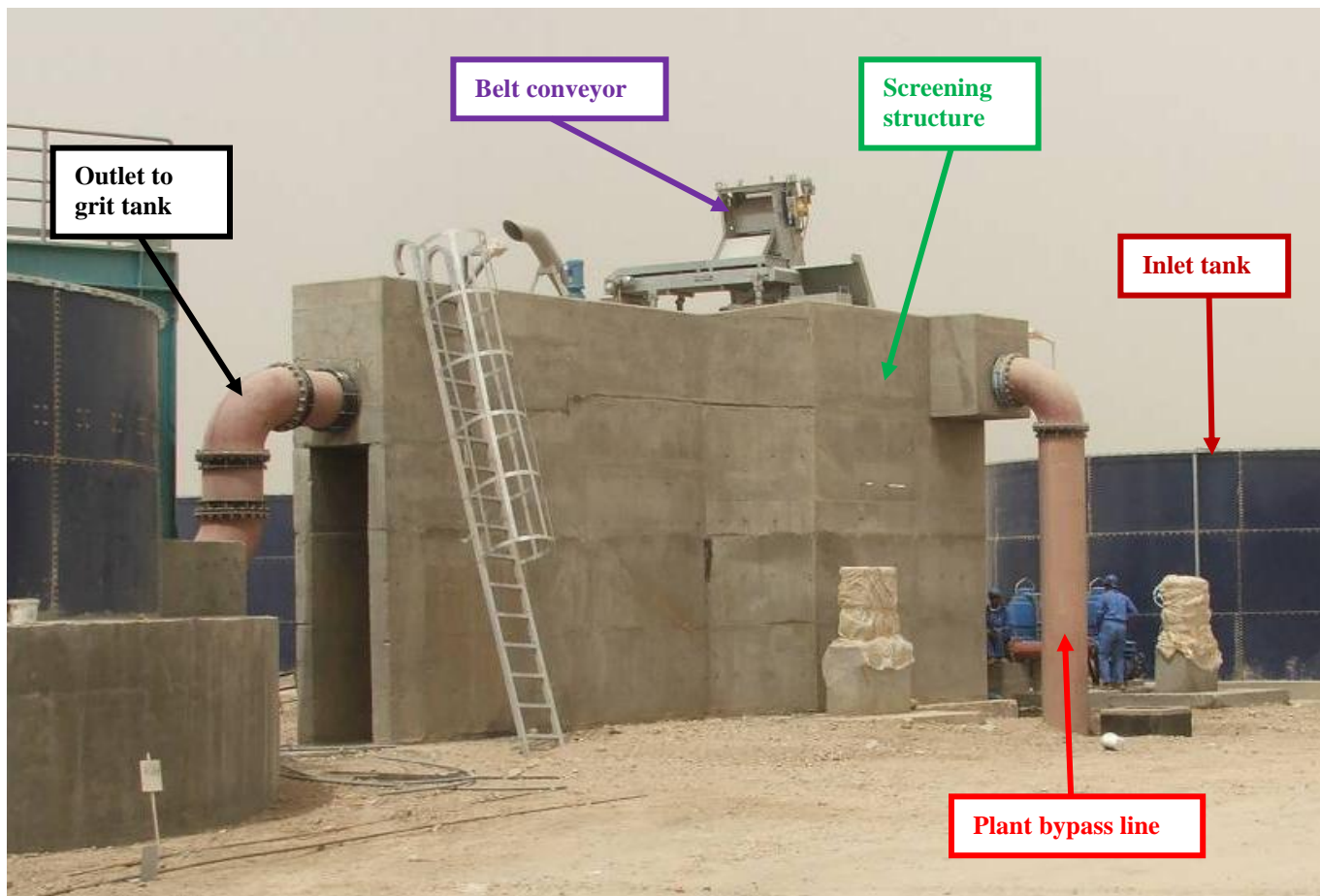
The IRRF funded Contract W91GY1-06-C-0047 was awarded to a local contractor on 27 August 2006 in the amount of \$23,550,000. The objective of the contract was to construct the Falluja WWTP. The contract required the contractor complete the project within 390 days of the NTP, which was issued on 10 November 2007.

**Inlet Tanks**

The raw wastewater from Pump Station F1 is pumped through a force main that feeds the inlet tanks. There are four inlet tanks, with each tank associated with one train. The inlet screens capture large suspended material that could foul or damage equipment. The mechanical screen needs to be raked periodically. At the end of the screen raking cycle, screenings are dropped onto a conveyor belt and conveyed to the compactor. Compacted screenings will be dropped into a dumpster for disposal.

We observed the steel inlet tanks (Site Photo 8) and concrete foundations, which appeared to be constructed appropriately. The inlet screens were installed but could not be inspected. Camp Falluja Resident Office representative stated that hydraulic testing of the installed tanks had been completed.





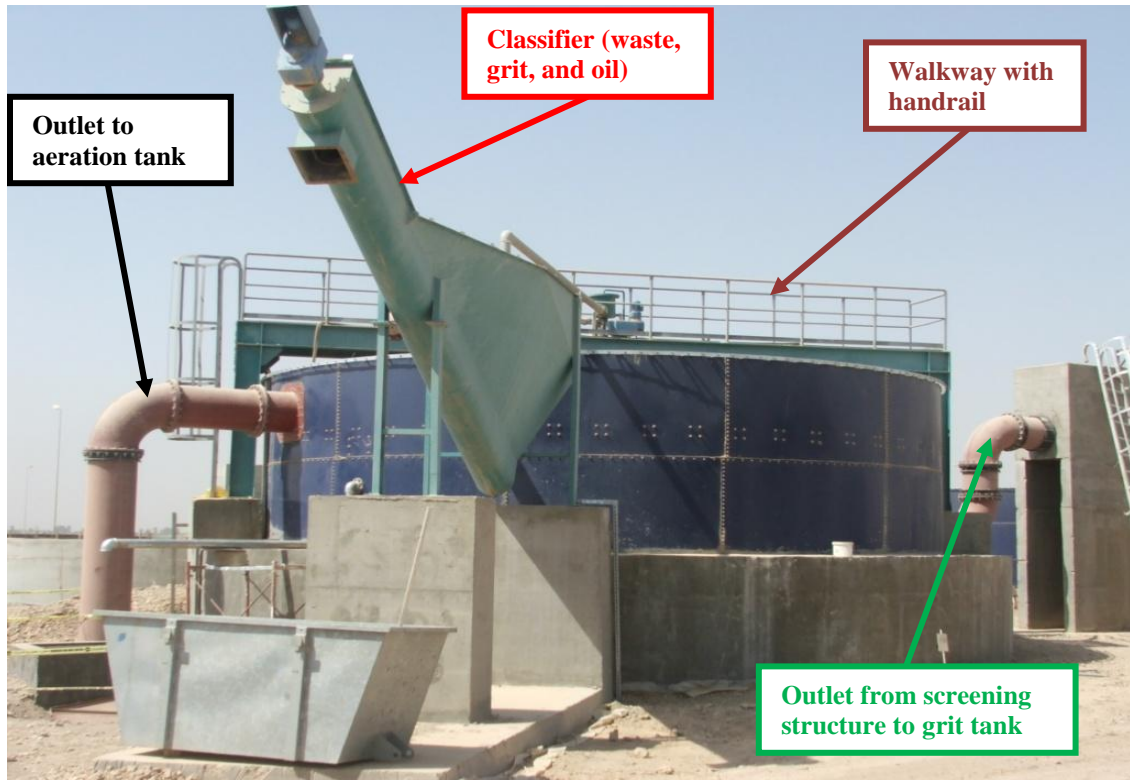
**Site Photo 8. Inlet tank and screen structure**

### Grit and Oil Removal System

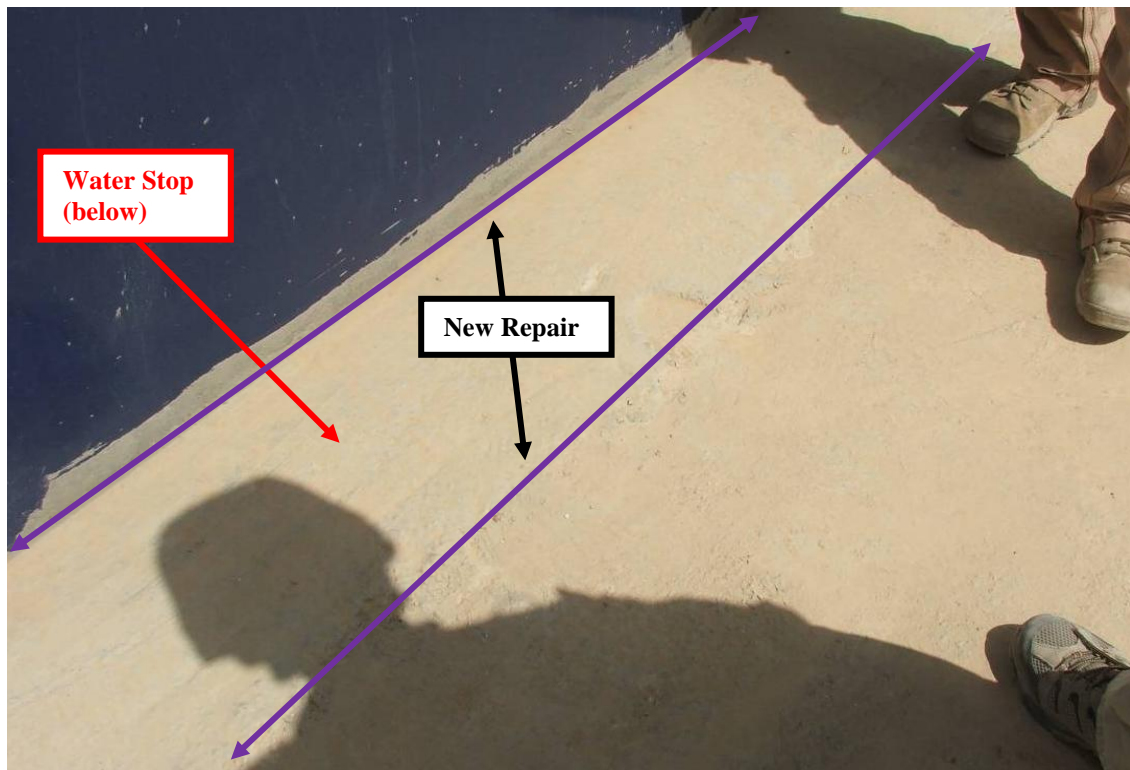
The grit entering the tank settles while the airlift pump system lifts the grit through the stand pipe to the grit classifier. Air flow to the air-lift pump is supplied by a single continuously operating small blower mounted on the bridge. The aeration system in the grit and oil removal tank has diffused air pipes mounted along the tank walls. Air flow to the skimmer diffusers is supplied by a branch off the air lines from the nearest aeration tank.

The grit and oil removal steel tanks and concrete foundations appeared to be adequately constructed (Site Photo 9). Camp Falluja Resident Office representative stated that the water stops at the connection between the steel tanks and the concrete foundations had leaked in several areas of the plant. This required the removal of some of the concrete so that the water stop could be repaired. The repairs appeared to be an epoxy-cement and are solid, which should result in satisfactory performance. We observed the top of the several tanks' foundations showing signs of this repair (Site Photo 10).





Site Photo 9. Oil and grit tank and classifier



Site Photo 10. Example of concrete repair



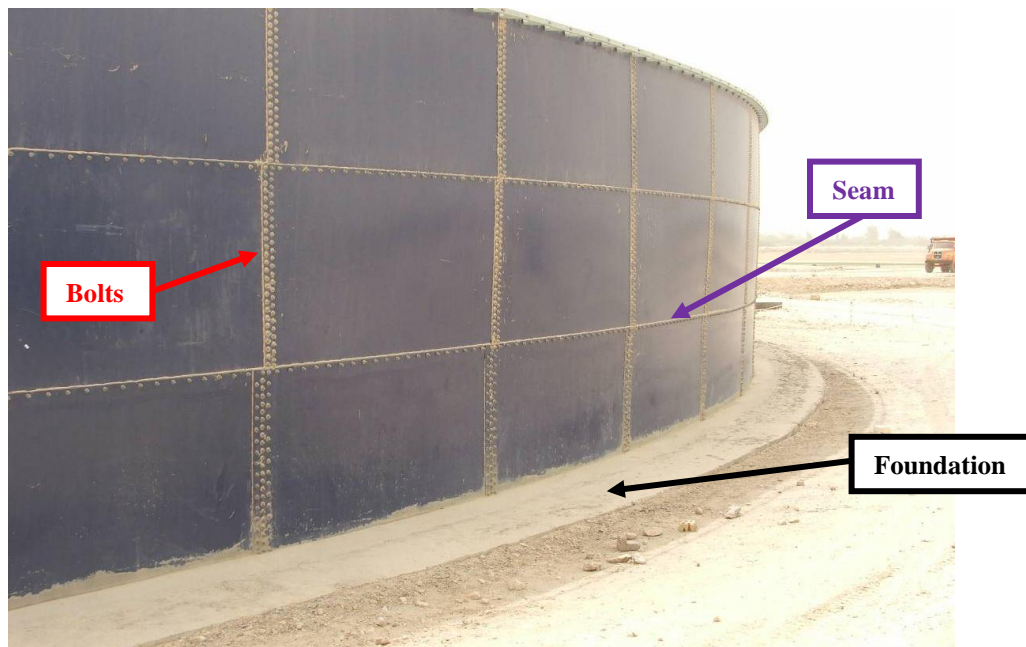
### Aeration System

Inflow to the aeration tank is gravity overflow from the grit tank. The aeration system includes the following:

- aeration tank
- positive displacement blowers
- fine bubble tube diffusers

Each aeration tank has fine bubble diffusers, which are mounted to 100 millimeter (mm) polyvinyl chloride (PVC) pipes. Influent wastewater is aerated to form “activated sludge” – a bacterial colony that degrades influent waste strength as monitored by Biochemical Oxygen Demand and Chemical Oxygen Demand removal tests. As some of this sludge is lost to the downstream final settling tank through overflows, it must be returned by pumps from the downstream holding tank and thus becomes Return Activated Sludge. Additionally, some sludge must be removed daily to maintain a healthy balance between the population of bacteria (the activated sludge) and its food source (the incoming wastewater), which is accomplished on an ongoing basis by pumping sludge (wasting sludge) from the sludge holding tank to the polymer mixing tanks and downstream drying beds.

At the time of the site visits, two of the large steel aeration tanks had been installed (Site Photo 11). The tanks are constructed in sections and are bolted together on site. Each bolt and tank seam appeared to have sufficient amounts of sealant, and according to a Camp Falluja Resident Office representative, the hydraulic testing of the tanks has been completed. The Camp Falluja Resident Office representative stated some of the PVC diffusers in the tanks have been exposed to sunlight and will need to be replaced before commissioning. Some PVC materials degrade when exposed to sunlight, but once operational, the materials will be under the surface of the water and will not be exposed to sunlight except for during maintenance periods. The subgrade for two more aeration tanks was compacted and was ready to start constructing the foundations.



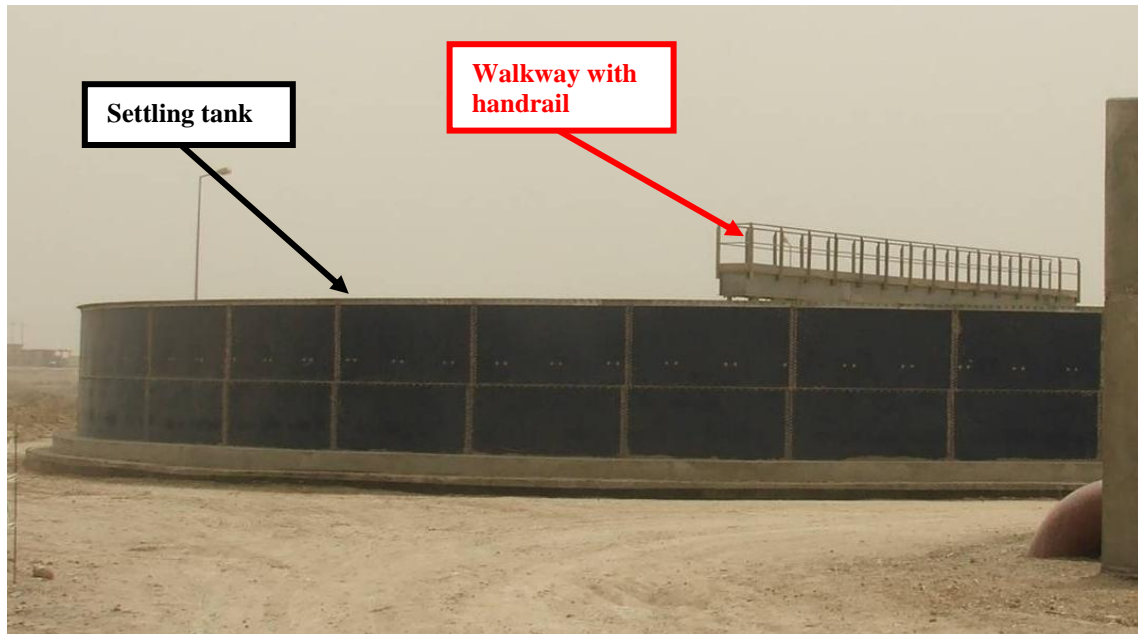
Site Photo 11. Aeration tank



### Final Settling Tank (Clarifier)

The package plant equipment provides for gravity discharge to downstream final settling tanks. The final settling tank is equipped with a bridge drive and scraper.

We inspected the final settling tanks for two of the treatment trains (Site Photo 12). The steel tanks, concrete foundations and mechanical equipment appeared to be installed in accordance with the design drawings. Camp Falluja Resident Office representative stated the underground piping and underground electrical wiring has been installed; however, the electrical wiring has not been completed in the Electrical Building.



**Site Photo 12. Settling tank and concrete foundation**

### Chlorination

Each package plant train was provided with two chlorinators and two chlorine booster pumps to provide chlorine at each chlorine contact tank. Since this WWTP consists of multiple treatment plants, chlorination equipment was designed to be arranged together in a single Chlorine Building where chlorine container replacement is facilitated and chlorine leak detection and mitigation can be provided. Chlorine solution from the chlorinators will disinfect settled water entering each chlorine contact tank.

At the time of the site visits, the chlorine contact steel tanks and concrete foundations had been installed for the first two trains (Site Photo 13). The tanks and foundations appeared to be adequately constructed and in accordance with design drawings. The Chemical Building was not complete and no equipment was installed.





**Site Photo 13. Chlorine contact tank and chlorine building**

### *Effluent Pump Station*

The pump station is a fill and draw system accommodating both treated wastewater and bypassed overflows. Multiple pumps will cover a range of flow conditions. The effluent pump station will allow the pumping of treated effluent as well as bypassed plant overflows to the plant outfall.

At the time of the site visits, the effluent pump station was partially constructed (Site Photo 14). The reinforced concrete walls were being formed to pour in the near future. The pump installation, piping connections, and backfill around the pump station still need to be completed.



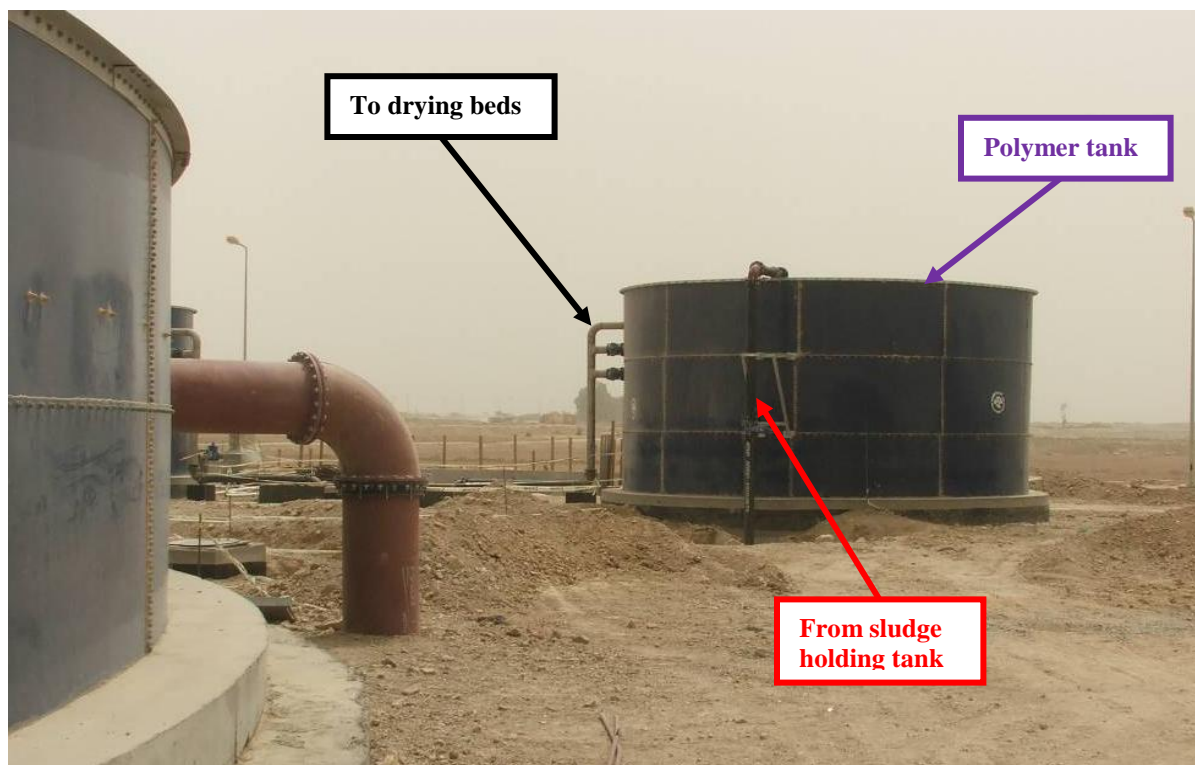
**Site Photo 14. Effluent pump station construction**



### Polymer

Polymer is sometimes added to the sludge to help in the efficiency of the dewatering process. The polymer system will utilize bag-addition of dry polymer chemical to a hopper feeding a mix/age tank filled by plant service water.

During our site visits, we observed two installed polymer mixing tanks<sup>14</sup>, which appeared to be constructed in accordance with design drawings (Site Photo 15). Camp Falluja Resident Office representative stated that initial commissioning will not use the polymer mixing tanks to its full potential because the gravity belt thickener is not being purchased with this contract; rather the interim process will be to inject the polymer into the sludge and send it to the sludge drying beds. The Camp Falluja Resident Office representative was concerned with using the polymer mixing tanks without having a gravity thickener to process the sludge. The primary concern is that the sludge polymer mixture would become too solid and the pumps would not be able to move the mixture to the drying beds. Pumping solid materials could result the clogging of the pipes and reduce the life of the pumps.



Site Photo 15. Polymer mixing tank

### Surge Storage Basin

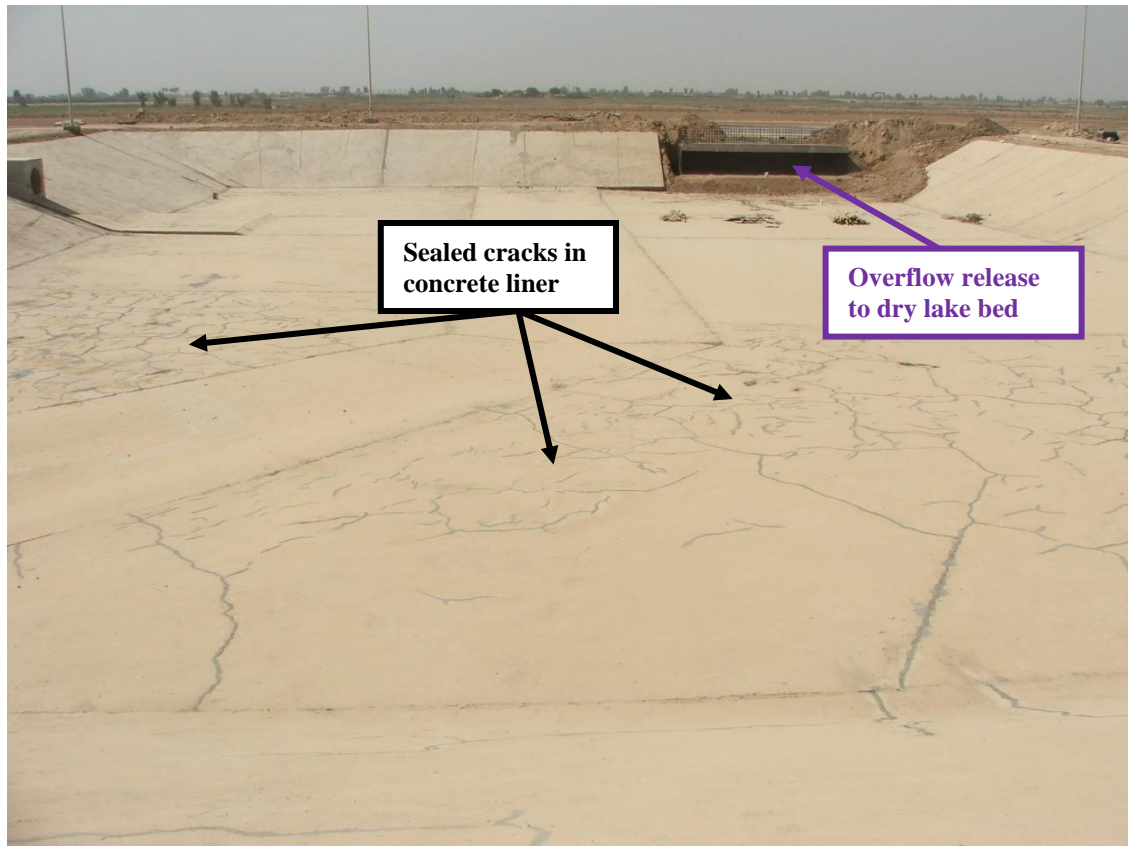
The U.S. government's design team determined that influent flow rates were expected to exceed the pumping and treatment capacity of the plant, which would result in raw sewage discharging directly into the Euphrates River. The WWTP was redesigned with surge storage basin capacity to accommodate anticipated influent wastewater flows that exceed the combined pumping ability of the package treatment system resulting in two 10,000m<sup>3</sup> basins and associated return pump station that will facilitate control and provide for cleaning and maintenance.

---

<sup>14</sup> Previous designs also referred to polymer mixing tanks as the sludge thickening tanks or the polymer conditioning tanks.



We observed the two constructed surge basins (Site Photo 16). The configuration of the surge basins appeared to match that of the construction specifications. An emergency overflow structure was constructed in the first basin and an equalization pipe was installed in between the two basins. The basins were constructed of earth fill material and were lined with concrete. According to the Camp Falluja Resident Office representative, the contractor requested to use concrete for the liner instead of the specification requirement of a cement/earth mixture. We noticed several cracks in the liner; however, the cracks appeared to be adequately sealed.



**Site Photo 16. Surge basin**

### Sludge Drying Beds

The sludge drying beds provide for the collection and pumping of leachate to the plant headworks and sludge drying. When the sludge is dry enough to handle with rakes, it will be raked and removed by trucks to a disposal site.

We observed the sludge drying beds (Site Photo 17), which were constructed of reinforced concrete with granular bedding materials installed to filter the sludge/water mixture. The sludge drying beds appeared to be constructed in accordance with design specifications. The water flows through the granular media and is pumped back to the inlet tank. The sludge is trapped on the media and when sufficiently dried is removed and disposed of off-site.





Site Photo 17. Sludge drying beds

## **Pump Station F1**

### **Contract W917-BG-06-C-0125**

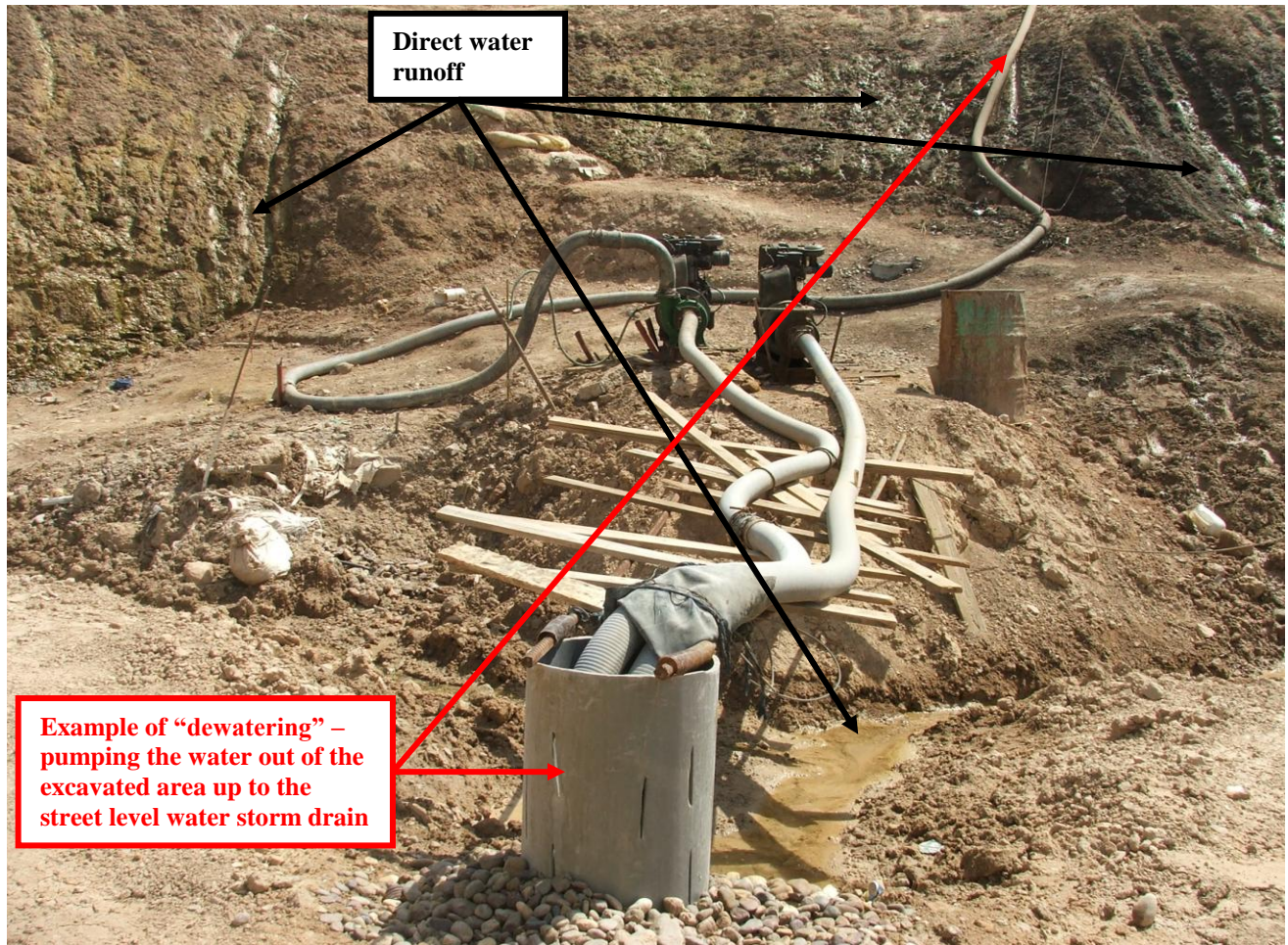
CERP funded Contract W917-BG-06-C-0125 was awarded to a local contractor on 1 June 2006 in the amount of \$3,490,379. The objective of the contract was to construct Pump Station F1 (F1), Pump Station F2, and Pump Station F3<sup>15</sup>. The contract required the contractor complete the project within 270 days of the NTP, which was issued on 17 August 2006.

The main lift station (F1) is located on the south side of the city of Falluja in a densely populated area; all the wastewater flow from the entire city of Falluja flows to Pump Station F1, which pumps it to the WWTP.

Upon our arrival at the project site, we immediately noticed the significant amount of direct water runoff coming from the excavation of the wet and dry wells. As with many areas of Falluja, the groundwater table at the pump station is very shallow due to the small elevation difference between the Euphrates River and the city. The contractor installed dewatering equipment in an attempt to pump the water out of the excavated area (Site Photo 18). The dewatering equipment sent the water runoff to the local storm water drain. The excavation for the F1 facility was in excess of 10-m deep.

<sup>15</sup> Pump Station F3 was later de-scoped from the contract.





**Site Photo 18. Water runoff and dewatering system**

The F1’s reinforced concrete walls were being formed to pour concrete (Site Photo 19). The steel reinforcement had been erected and the walls appeared to be constructed in approximately 2 meter sections. In between each section of the wall construction a water stop gasket was installed. During our site visit, we observed areas of inadequately poured concrete (Site Photos 20 and 21). The Camp Falluja Resident Office representative stated the unacceptable concrete work had previously been identified on a deficiency list from a previous quality assurance (QA) report. The unacceptable areas have been marked and the contractor will remove and replace it. The Camp Falluja Resident Office representative brought the contractor over to the areas in question and reiterated to the contractor that the deficient must be replaced. The contractor agreed to remove and replace the deficient concrete. The pump station floor was constructed of reinforced concrete, which appeared acceptable.





**Site Photo 19. Pump Station F1 wall construction**



**Site Photo 20. SIGIR Inspector checking concrete work**



**Site Photo 21. Inadequate concrete area (behind cover)**



# Project Quality Management

## **Contractor's Quality Control Program**

Department of the Army Engineering Regulation (ER) 1180-1-6, dated 30 September 1995, provides general policy and guidance for establishing quality management procedures in the execution of construction contracts. According to ER 1180-1-6, "...quality construction is a combined responsibility of the construction contractor and the government."

The contractor for each project site submitted quality control (QC) reports on a daily basis, which Camp Falluja Resident Office representatives review for adequacy and completeness. The daily QC reports provide the following information:

- type of personnel and major equipment
- activities performed
- security issues
- safety violations
- tests and inspections performed

Included with each daily QC report were multiple photographs of activities performed. While the captions for each photograph are neither very descriptive (i.e. "Earth work in different places") nor do they document safety violations or deficiencies, the daily QC reports and photographs provide Camp Falluja Resident Office personnel with a daily look at the construction activities being performed.

Contractor test results are also submitted to Camp Falluja Resident Office representatives, who review and log them; however, Camp Falluja Resident Office representatives "do not place a lot of confidence in them." Specifically, Camp Falluja Resident Office representatives believe 3<sup>rd</sup> party independent testing laboratories:

- are not "independent"
- have little "integrity"
- have no primary-source traceable calibration devices or calibration certification, and no certifying body available to help them out

According to Camp Falluja Resident Office representatives, the contractor's daily QC reports "show us what the contractor wants us to see, so we are always aware of that situation;" yet to Camp Falluja Resident Office representatives, who are unable to visit the project sites daily to gauge work activities performed, the daily QC reports are "certainly" useful.

## **Government Quality Assurance**

The USACE ER 1110-1-12 and PCO Standard Operating Procedure (SOP) CN-100 specified requirements for a government QA program. Similar to the QC program, a crucial oversight technique is presence at the construction site.

As mentioned throughout this report, the security situation in and around this project has been extremely volatile, which has severely limited the ability of Camp Falluja Resident Office representatives to perform the type of QA oversight they would like (and this project requires). The constant threat of attacks either on site or the drive to and from the site (via IEDs and/or small arms fire) has curtailed the frequency and duration of Camp Falluja Resident Office representatives' project site visits to bi-weekly and for approximately 1-2 hours.



### Engineering and Field Inspection Support Contract

The technical precision and contractor safety issues for the overall project requires QA oversight greater than what Camp Falluja Resident Office representatives could offer due to the above-mentioned security reasons. In an effort to support the Camp Falluja Resident Office representatives, Contract W917BG-06-C-0213 for \$1,360,640 was awarded to provide the Camp Falluja Resident Office representatives with office engineering services and field engineering and inspection services during construction. The field engineering and inspection services required the following:

- prepare daily field reports on construction activities and observations
- observe the construction contractor's work on site during construction and make field observations
- take progress of construction photographs
- prepare final punch list

The contract required the field engineers to be Falluja residents familiar with the "City, its traditions, and protocols for constructing public works." The use of local residents allowed easier access to the project sites and an extended amount of time on site. For example, in April 2007, the following personnel were assigned to perform construction contractor oversight:

- Project Manager (1)
- Senior Field Manager (1)
- Civil Engineer (1)
- Mechanical Engineer (1)
- Electrical Engineer (1)
- Civil Inspector (3)
- Civil Inspector (1)
- Civil Inspector (1)
- Civil Inspector (1)
- Civil Inspector (1)
- Surveyors (2 x 2)

According to Camp Falluja Resident Office representatives, the field engineers served as quality assurance representatives (QARs) at the project sites since they could visit the sites daily. These engineers were on site during construction events, monitored field activities, and completed daily QA reports, which were forwarded to Camp Falluja Resident Office representatives for review. The daily QA reports documented significant construction activities and was accompanied by photographs of construction work performed throughout the day. The QARs used descriptive wording to note any problems/deficiencies identified at the project sites. For example, in the 30 June 2007 daily QA report, the QAR captured a construction deficiency through the use of a photograph and the caption "deep crack and settlement in the lighting pole base" (Site Photo 22). Camp Falluja Resident Office representatives think of the QARs as their "eyes and ears on the ground."





**Site Photo 22. Deficiency identified in daily QA report by field engineers  
(Courtesy of the USACE)**

### **Camp Falluja Resident Office Efforts**

Even though security concerns restrict the frequency and duration of project site visits, Camp Falluja Resident Office representatives manage the quality aspects of the construction as best as they can under the prevailing conditions.

Camp Falluja Resident Office representatives provide conventional QA oversight of the contractor through the thorough review of the daily contractor QC reports and the daily field engineers' QA reports. Project file documentation shows emails between contractors and field engineers with instructions to repair poorly installed construction joints in concrete water retaining structures by providing repair procedures to the contractors. In addition, Camp Falluja Resident Office representatives maintain project deficiency lists, which require constant oversight to ensure satisfactory resolution. These deficiencies are often long lead time issues as the contractors are often reluctant to re-visit work they feel they have already completed; however, the relentless efforts by the Camp Falluja Resident Office representatives ensure the repair of the specific deficiency.

### **Unrealistic expectation of contractors**

As mentioned earlier in this report, the security situation in Falluja throughout the duration of this project required the use of local contractors and subcontractors almost exclusively for the construction work. However, the use of local contractors and subcontractors was questionable since they were unfamiliar with the sophisticated construction techniques and equipment necessary to complete this complex project.



In addition, Camp Falluja Resident Office representatives state that contractors in the U.S. are capable, experienced, aware, and liable for any accidents; while it is “a very different situation” in Falluja. With regards to safety, fatalities often occur because workers “do not know what is dangerous and what is not.” Further, Camp Falluja Resident Office representatives stated that the local contractors are unaware of acceptable Western quality standards (i.e. ISO 9000 Series) and other international standards, such as American Water Works Association (AWWA) and American Welding Society (AWS).

#### Minimum Acceptable Quality

Contractor site safety issues and limited technical capabilities present constant, significant concerns; however, due to security constraints, Camp Falluja Resident Office representatives are restricted to bi-weekly visits to the project sites. Therefore, according to Camp Falluja Resident Office representatives, the goal is to achieve a “minimum acceptable quality” at the project sites, which they believe is a realistic approach to managing this project. Camp Falluja Resident Office representatives are quick to point out that minimum acceptable quality does not mean diminished quality in any way, but rather a practical approach when taking into consideration security, safety, and the desire for project progress.

With limited opportunities to visit project sites, Camp Falluja Resident Office representatives must maximize the usefulness of each site visit while still attempting to achieve “minimum acceptable quality.” Camp Falluja Resident Office representatives determine the criticality of the structure or work being installed/constructed. For example, water-retaining pump station or tank, WWTP Return Pump Station, and 10-m deep trunk mains are classified as critical; while collection network piping is not so critical (since the MMPW has the capability to replace damaged pipe/manholes in the future). Camp Falluja Resident Office representatives stated that for critical structures, such as the water-retaining pump station or tank, they are careful to obtain the best quality possible and enforce adequate repairs. Camp Falluja Resident Office representatives provided the example of Pump Station F1, where they have had a long running battle with the contractor to install and join water-stops correctly. The contractor ignored instructions regarding correct installation and the expansion joint leaked. Camp Falluja Resident Office representatives engaged the design engineers to determine the best materials for repairing the joint. Camp Falluja Resident Office representatives are tracking a specialist supplier, and a specialist applicator. Even though this slowed down work and cost the contractor additional money, Camp Falluja Resident Office representatives know this important problem is being dealt with professionally.

#### Concrete Strength Improvements

Camp Falluja Resident Office representatives have instituted improved concrete specifications for the WWTP and the pump stations. The original design required a water: cement ratio of 0.45 with a compressive strength of 3,500 pounds per square inch (psi). Camp Falluja Resident Office representatives took the initiative to have the water-to-cement ratio changed to 0.38, with a super-plasticizer added to ease placement without segregation. This concrete provides a vastly improved durability from higher concrete density (lower water penetration leading to higher protection of the steel from corrosion), which resulted in the reduction of plastic shrinkage cracking. In addition, this provides concrete compressive strength test results in a range from 30 megapascals (MPa) minimum to 50-MPa maximum. Since this range far exceeds the Characteristic Strength of 25-MPa, even the lowest results are above the minimum Characteristic Strength. This also overcomes the deficiencies of the concrete production plants where calibration of weigh bins for water and aggregates is questionable. By increasing the cement content and reducing the water content, Camp Falluja Resident Office representatives now do not worry as much about concrete batch plant variability. Camp Falluja Resident Office representatives consider this an “insurance



policy” to overcome the “inherent flaws in concrete production and placement that exist in the Iraqi construction industry at present.”

### *Safety Briefings*

Throughout the duration of this project, Camp Falluja Resident Office representatives have made a concerted effort to promote safety as much as quality with the local contractors. According to Camp Falluja Resident Office representatives, encouraging the use safe construction practices is much more difficult in Iraq than in the U.S. Specifically, in the U.S. the Occupational Safety & Health Administration enforces safety; while there is no equivalent in Iraq. As a result, Camp Falluja Resident Office representatives feel they need to protect the contractors from their own unsafe construction techniques and practices.

In addition to visiting project sites to verify workers are wearing the required protective equipment (i.e. hard hats, gloves, etc) and using scaffolds, Camp Falluja Resident Office representatives provided numerous safety briefings. After a fatality, Camp Falluja Resident Office representatives immediately held safety briefings in order to avoid additional injury or loss of life. For example, after the confined space asphyxiation fatality, Camp Falluja Resident Office representatives gathered all site team managers, site supervisors, and field engineers personnel and gave a safety training course (in Arabic) specifically targeted at Confined Space Management. All participants were required to sign an attendance sheet to document their presence at the training.

### *Mentoring Iraqi Contractors*

Camp Falluja Resident Office representatives spend time with the local contractors in an effort to mentor them with regards to construction techniques and safety issues. For example, none of the local contractors practiced employing scaffolds; instead often times relying on the use of a plank across two barrels. Camp Falluja Resident Office representatives ended this extremely dangerous practice and enforced the use of scaffolds (Site Photo 14). In addition, Camp Falluja Resident Office representatives require all contractors use gloves and hard hats.

During the two site visits, SIGIR witnessed Camp Falluja Resident Office representatives engage the multiple contractors on site by pointing out deficient practices and encouraging the use of alternative techniques. When the contractors protested and/or did not address previously identified deficiencies, Camp Falluja Resident Office representatives required the contractors visit their office the next day to resolve the issue.

Camp Falluja Resident Office representatives also became involved on the contractor’s behalf with respect to illegal taps into the Collection System A line. After the fatality in the collection system, Camp Falluja Resident Office representatives advised the Falluja Sewer Directorate (FSD) that unless the illegally tapped sewage from the under-construction pipe networks is pumped out, the collection systems may not be re-opened for completion. Camp Falluja Resident Office representatives were concerned that the FSD would “pressure” the contractors to pump it out. A Camp Falluja Resident Office representative stated he broached the subject with the contractors, who appeared “to be amenable to helping out.” However, the Camp Falluja Resident Office representative “instructed the contractors during the safety training brief that under no circumstances are their workers to enter ANY manhole that is not clear of sewage. We have also reinforced the fact that the individual has the right to say NO when asked to enter any work area which he perceives to put him at risk.”

In addition, Camp Falluja Resident Office representatives were concerned about the well being of the Falluja residents who were illegally tapping into the collection system. First,



Camp Falluja Resident Office representatives requested the contractors remove all pipe plugs from all pipes at the end of each working day, which would ensure there is no reason for any citizen to enter any manhole. Then Camp Falluja Resident Office representatives met with city leaders in an attempt to get them to use their influence over the city's residents. However, Camp Falluja Resident Office documentation noted the following:

*"It is difficult for the City MMPW and FSD to actually BAN the illegal tapping. However, they do agree to issue Press Release posters and to discuss in the wider City Council."*

Ultimately, posters were prepared to warn Falluja residents of the dangers of entering manholes (Appendix J).

### **Safety Accidents Still a Major Concern**

As mentioned earlier in this report, safety accidents, including four fatalities, have occurred during construction activities over the course of this project. Unfortunately, even the best intentions and teachings of the Camp Falluja Resident Office representatives with regard to safety practices have often been ignored by the local contractors and subcontractors. According to Camp Falluja Resident Office representatives, the local contractors continually state they "knew what they were doing" while continuing to use unsafe and dangerous construction techniques. Camp Falluja Resident Office representatives state that part of their job consists of trying to save the contractors from themselves (i.e. using the unsafe practices). Both the field engineers and Camp Falluja Resident Office representatives use unannounced site visits to verify the contractors' construction techniques. Camp Falluja Resident Office representatives then reprimand each nonconforming contractor with photographic evidence of unsafe practices. A Camp Falluja Resident Office representative feels that safety is a "constant worry and a constant fight," which he finds "excessively grueling."

## **Sustainment**

At the inception of this project, the U.S. government wanted the WWTP to consist of a lagoon system because it required little power, no skilled personnel, and little maintenance to operate. However, the MMPW rejected outright the lagoon system because it was for "third world countries;" instead requesting to use a mechanical (activated sludge unit) system. Even after a study comparing the two systems recommended the use of a lagoon system and thoroughly countered all of the MMPW's objections, the MMPW continue to refuse the lagoon system. Ultimately, the U.S. government decided to accept the MMPW's proposal of using four activated sludge units as the basis for the WWTP. This decision had significant, irreversible, and long term ramifications on the future operation and maintenance of the WWTP and associated facilities. Specifically, the newly designed WWTP required a substantial amount of permanent power and skilled personnel to operate and maintain.

### **Permanent Power**

As mentioned earlier in this report, the city of Falluja, in mid-2004, was in the middle of intense military conflict between CF and insurgents. At the time, the city residents had little, if any, access to essential services, such as potable water and permanent power. In mid-2004, when the original DO was awarded to FluorAMEC, the U.S. government assumed the entire project would require little power (since the lagoon system requires little power, the only permanent power would be required at the pump stations). However, when the U.S. government decided in November 2005 to re-design the WWTP from a lagoon to a mechanical system, the need for



permanent, reliable power became critical. In an effort to use locally available power, the U.S. government, on 2 June 2006, awarded a contract using DFI funds to construct 11-kV electrical feeder lines underground from a 33/11-kV substation to the WWTP and the pump stations. However, by July 2007, U.S. government representatives acknowledged that “another critical factor...is the unreliability of a permanent power supply.” Specifically, “power is only available for short periods” and often comes in the form of surges. GRD Electricity Sector representatives stated they did not “expect any significant improvements [for permanent power] in the foreseeable future.”

### Continuous-use Generators

As a result, the solution to the lack of permanent power was to redesign the WWTP from standby generators to continuous duty generators. The U.S. government awarded a DFI funded contract, in the amount of approximately \$1.75 million to provide continuous duty generators for the WWTP and three pump stations<sup>16</sup>. However, according to GRD representatives, it will take 520 gallons of fuel per hour (12,480 gallons per day) to operate the generators at the WWTP and pump stations at full capacity to service the entire wastewater treatment system (all four WWTP trains and three pump stations servicing all eight collection areas); while it will require 200-250 gallons of fuel per hour (4,800 – 6,000 gallons per day) to operate the limited service portion of this project (two of the four WWTP trains and two pump stations for three collection areas). Considering GRD representatives are optimistic that the limited service portion of this project, servicing approximately one-third of the originally intended houses in Falluja, will be partially operational in April 2009 (two of the four WWTP trains and two pump stations), the GOI needs to quickly implement a system in place to provide a total of at least 4,800 – 6,000 gallons of fuel per day to multiple sites throughout the city of Falluja on a daily basis. However, after the GOI completes the remaining portions of the wastewater treatment system, this requirement will escalate to 12,480 gallons of fuel per day. The lack of fuel, even if for only a single day, would result in the back up of wastewater into the houses of Falluja residents.

Currently, no awarded contracts require providing the amount of fuel needed to operate the generators at the WWTP and pump stations; instead the MMPW will be responsible for providing the fuel.

Considering the significant amount of fuel required, we inquired about the ability of the MMPW to deliver the necessary amount of fuel daily to operate this wastewater treatment system. ITAO, GRD, and JCC-I/A representatives stated there is no assurance the MMPW will provide the required amount of fuel. Bearing in mind the gravity of the situation (in the case of the MMPW not providing the necessary amount of fuel), GRD representatives responded with the following:

*“...fuel is considered a consumable to be provided by the GOI. Also similar to the plant chemicals, the ability of the GOI to provide fuel will be closely monitored. The GOI will not be left in a difficult situation without any warning, as coordination efforts will be made in advance. As mentioned above, the goal is for the GOI to be in a position to effectively continue plant operation well after completion.”*

### Operations and Maintenance Issues

WWTPs and pump stations, like all factories and mechanical facilities, must be maintained to ensure proper long term operations. WWTPs and pump stations of this type and size must have qualified personnel to perform daily maintenance on the pumps, motors, generators, and moving

---

<sup>16</sup> This DFI funded contract was ultimately terminated by the U.S. government. The contract was subsequently re-awarded to another contractor using IRRF funds.



mechanical parts, as well as, consumables such as motor oil, filters, grease, and coolants. The lack of trained personnel to perform preventative maintenance or consumables can shorten the life expectancy of the mechanical equipment and can cause intermittent treatment, which results in poor discharge quality.

#### Trained Personnel and O&M Plant and Operations Support

According to the comparison study, the mechanical (activated sludge unit) system desired by the MMPW “needs to be monitored continuously by skilled personnel to ensure reliability and effluent quality.” According to Camp Falluja Resident Office representatives, operating the WWTP will require approximately 150 people. Camp Falluja Resident Office representatives stated the MMPW Director General (DG) for Sewage has a list of 150 people to operate and maintain the WWTP; however, the knowledge and skills of these individuals are unknown. The existing WWTP base contract includes 40 hours of on-site training and 90 hours of O&M post-commissioning support; yet the level of quality training the contractor can provide is unknown.

Originally, GRD representatives tentatively planned to contract for one year of O&M plant and operations; however, due to budget constraints, GRD representatives intend to de-scope the training and O&M post-commissioning support requirements from the existing base contract and provide more comprehensive pre- and post-commissioning training. A scope of work is currently established for two months of classroom training prior to commissioning and six months of post-commissioning on-the-job-training (advise and assist).

#### Consumables

In addition to motor oil, filters, grease, and coolants for the WWTP and pump stations’ machinery, the WWTP, once fully operational, will also require a regular supply of chlorine for the disinfection of the wastewater and polymer to thicken the sludge. The lack of a consistent supply of chlorine or polymer will affect the quality of the treated effluent being discharged into the Euphrates River. Therefore, consumables are crucial in order to provide consistently treated effluent and prevent costly equipment failures.

Originally, GRD representatives tentatively planned to contract for one year’s worth of consumables for the WWTP and pump stations. However, due to budget constraints, “there is no USG contract for consumables.” According to GRD representatives, the plan forward is the following:

*“plan forward is to engage the MMPW/GOI in plant commissioning and have them provide consumables...The general idea is that if the GOI cannot provide consumables during commissioning, then they are not going to suddenly be able to provide needed chemicals, fuel, etc. after plant turnover. The ability for the GOI to provide commissioning consumables will be closely monitored.”*

#### Effects of Sustainability Issues

The sustainability issues identified in the previous paragraphs present serious problems for both the U.S. government and the GOI. Specifically, if the GOI cannot provide an adequate amount of fuel to continuously operate the WWTP and pump stations 24 hours per day, 7 days per week, the Falluja Waste Water Treatment System will not operate and wastewater will ultimately back up into the homes of Falluja residents. If this issue is not resolved, the substantial investment by the U.S. government will be wasted and the residents of Falluja will continue to not have a useable comprehensive wastewater system.



## **Additional Challenges**

In addition to the critical fuel issue, there are two additional challenges the U.S. government and the GOI need to address in order for this project to achieve its objective of providing a comprehensive wastewater treatment system for a portion of the Falluja residents.

### **House Connections**

According to the collection systems' SOW, the contractor was required to install 100-mm house connection pipe to within 1-m of the property line; the MMPW would then be responsible for connecting each house to the collection system. According to Camp Falluja Resident Office representatives, the MMPW – Sewer Directorate does not have available funding to perform this work; instead the MMPW proposes to allow each homeowner make his own connection to the collection system. Camp Falluja Resident Office representatives are extremely concerned about this proposal because they believe homeowners will simply knock a hole through the manhole walls, in the process damaging the collection system.

Currently, neither the U.S. government nor the GOI have funding in place to perform the house connection work; consequently, the residents of these areas will not benefit from the completed wastewater treatment system network. Further, this issue must be addressed and resolved quickly since the house connections have to be made prior to the commissioning of the wastewater treatment system. Final commissioning, including the collection systems, pump stations, force main, and WWTP, requires wastewater and without house connections, there will be no wastewater to flow the point of origin (house connections) through to the end point (treated wastewater delivered into the Euphrates River via the Outfall).

### **Force Main**

Mentioned earlier in this report, the contractor who constructed the Force Main has an outstanding balance with the Ministry of Finance (MoF) in the amount of approximately \$1.3 million. Until payment is received, the contractor will continue to deny beneficial occupancy by locking the manholes and valve boxes (Site Photos 3-5). Without the use of the force main, no wastewater will travel from Pump Station F1 to the WWTP, which will result in the backup of wastewater to individual residences.

According to ITAO representatives, the MoF is “days away” from making the payment to the contractor; however, as of 27 October 2008, the contractor has not been paid and continues to lock the manholes and valve boxes.

The two issues identified above present serious problems to both the U.S. government and GOI. Specifically, if the GOI does not provide house connections for the three collection systems, the remainder of the Falluja Waste Water Treatment System will be useless; while if the GOI continues to refuse payment to the contractor for the Force Main contract, the Falluja Waste Water Treatment System will not operate and wastewater will ultimately back up into the homes of Falluja residents. In either case, the U.S. government will have little to show for its substantial financial investment; while the residents of Falluja will continue to not have a comprehensive wastewater treatment system.



## **Actions Taken Since Draft Report**

### *U.S. Government Efforts to Get DFI Contractors Paid Net Results*

The ITAO has been actively pursuing the payment of DFI funded contracts with the MoF. At the time of the issuance of SIGIR's draft report, there were five DFI funded contracts with outstanding balances with the MoF in the amount of \$2,331,532; however, according to ITAO documentation, subsequent to the issuance of the draft report, two payments, totaling approximately \$570,000, have been made by the MoF. According to ITAO documentation, the MoF has approved the invoice packages for two additional contracts, including the Force Main. ITAO representatives stated the two invoices, worth \$1,645,967, are with the "DG of Accounts" who will process the payments through the Central Bank of Iraq. ITAO representatives stated they will continue to meet with the MoF weekly until the payment issue is resolved.

## **Conclusions**

Based upon the results of our site visit, we reached the following conclusions for our assessment objectives. Appendix A provides details pertaining to Scope and Methodology.

### **1. Determine whether project components were adequately designed prior to construction or installation.**

The wastewater treatment plant for the Falluja Waste Water Treatment System was originally designed using a lagoon system; however, because the Iraqi Ministry of Municipalities and Public Works refused to even consider a lagoon system, the U.S. government agreed to re-design the wastewater treatment plant using a mechanical system (activated sludge units). According to representatives of the Iraq Transition Assistance Office and the U.S. Army Corps of Engineers, the design drawings for both the wastewater treatment plant and the pump stations were "technically inadequate," which required the U.S. government to contract with Washington International, Inc./Black and Veatch to complete the construction package. For example, the contractor's design submittal for the wastewater treatment plant had "many technical issues" requiring Washington International, Inc./Black & Veatch to develop detailed designs for the chlorination system, scrubber, polymer slab, and polymer system design. In addition, a peer design review was required to bring the pump stations "up to international safety and engineering code compliance." Also, the original designs for all three collection systems were technically inadequate because the original design engineer was unable to complete site surveys because of security concerns.

After the project was re-designed two separate times at significant additional cost to the U.S. government, the contract's design and specifications were eventually revised to be specific enough to construct the wastewater treatment plant and associated facilities. The revised design has taken into consideration the sequencing of work and the relationship to other contract work. The revised drawings and specifications appear to be complete and consistent with the contract's requirements. However, it must be noted that the primary design concern of the Ministry of Municipalities and Public Works--the odor produced by a lagoon system--was not addressed by the original design of the wastewater treatment plant with the activated sludge units. During the design review process, this was identified; however, because of project funding constraints, it was not remedied. Consequently, the residents of Falluja, many of whom will not have access to the sewer system, may be subjected to significant odors emitted from the wastewater treatment plant.



2. Determine whether construction or rehabilitation is in compliance with the standards of the design.

The majority of the work observed met the standards of the revised designs. Because of the security situation, the inspection team was able to inspect only the wastewater treatment plant and Pump Station F1. At the wastewater treatment plant, no significant deficiencies were observed; however, at Pump Station F1, the inspection team observed an area of inadequately poured concrete. According to a representative of the Camp Falluja Resident Office of the U.S. Army Corps of Engineers Gulf Region Central, the unacceptable concrete work had previously been identified on a deficiency list and will be inspected for removal and replacement prior to issuance of final payment. The inspection team concluded that the Camp Falluja Resident Office provided adequate oversight to ensure that construction met the standards of the design.

3. Determine whether adequate quality management programs are being utilized.

The contractors' quality control plans were sufficiently detailed, including the use of daily quality control reports to document construction deficiencies. The daily quality control reports documented the number of workers on site, the construction activities performed, and provided numerous photographs of work activities performed. According to Camp Falluja Resident Office representatives, the contractor's daily quality control reports were useful but showed what the contractor wanted them to see.

The government quality assurance program was effective in ensuring that construction of the entire Falluja Waste Water Treatment System was adequate. The security situation in and around this project has been extremely volatile, which severely limited the ability of Camp Falluja Resident Office representatives to perform the depth of quality assurance oversight required for a project this large and complex. The constant threat of attacks either on site or during the drive to and from the site limited the frequency and duration of Camp Falluja Resident Office representatives' project visits to an hour or two every other week.

Technical precision and contractor safety issues for the wastewater treatment system required more quality assurance oversight than the Camp Falluja Resident Office could provide because of the security situation. Therefore, a contract was awarded to a local contractor that employed Iraqi engineers from the Falluja area as quality assurance representatives to perform field engineering and inspections services during construction. The quality assurance representatives were on site during construction events, monitored field activities, and completed daily quality assurance reports, which documented significant construction activities and included photographs of construction work performed throughout the day. According to Camp Falluja Resident Office representatives, the quality assurance representatives served as their "eyes and ears on the ground."

The lack of local contractors with the technical capabilities to perform construction activities that comply with international standards presented a constant challenge. According to Camp Falluja Resident Office representatives, their goal was to achieve a "minimum acceptable quality" at the project sites, which they believed was a realistic approach to managing this project. Camp Falluja Resident Office representatives believe that this goal does not mean diminished quality, but rather a practical approach when taking into consideration security, safety, and the desire for project progress.

Camp Falluja Resident Office representatives have instituted improved concrete specifications for the wastewater treatment plant and pump stations, which provided vastly improved durability from higher concrete density and provided concrete compressive strength test results that are well above the minimum required characteristic strength. Camp Falluja



Resident Office representatives consider this an “insurance policy” to overcome the “inherent flaws in concrete production and placement that exist in the Iraqi construction industry at present.” In addition, Camp Falluja Resident Office representatives mentor the local Iraqi contractors with safety briefings and construction techniques. Throughout the duration of this project, Camp Falluja Resident Office representatives made a concerted effort to promote safety as much as quality with the local contractors. Several accidents have occurred at the project sites—resulting in four fatalities. The deaths are a testament to the failure of the local contractors to conform to the safety practices recommended by the Camp Falluja Resident Office representatives.

The Camp Falluja Resident Office’s robust quality assurance program compensated for the technical and safety limitations of the local contractors. Specifically, the quality assurance program encouraged safety and quality while ensuring the completion of the project.

4. Determine if sustainability is addressed in the contract or task order for the project.

Sustainability was not adequately addressed for this project. At the inception of the project, the U.S. government wanted the wastewater treatment plant to consist of a lagoon system because it required little power, no skilled personnel, and little maintenance to operate; however, the Iraqi Ministry of Municipalities and Public Works rejected the lagoon system because it was for “third-world countries.” Instead the Ministry of Municipalities and Public Works requested the use of a mechanical (activated sludge unit) system. Ultimately, the U.S. government accepted the Ministry of Municipalities and Public Works proposal of using a mechanical system; this decision will have significant, irreversible, and long-term ramifications on the future operation and maintenance of the wastewater treatment plant and associated facilities.

When the original delivery order was awarded in mid-2004, little permanent power was required because the wastewater treatment plant was designed with a lagoon system. In November 2005, when the U.S. government agreed to redesign the wastewater treatment plant from a lagoon to a mechanical system, the need for permanent, reliable power became critical. In June 2006, a contract funded with Development Fund for Iraq funds was awarded to provide power to operate the newly designed mechanical wastewater treatment plant and Pump Station F1--specifically, feeder lines connecting the plant and pump station to a local substation.

However, by July 2007, U.S. government representatives realized that the Iraqi National Grid would not provide “any significant improvements [for permanent power] in the foreseeable future.” As a result, the solution to the lack of permanent power was to further redesign the wastewater treatment plant to operate by continuous-use generators instead of standby generators.

According to Gulf Region Division representatives, it will take approximately 520 gallons of fuel per hour (12,480 gallons per day) to operate the generators for the full running of the wastewater treatment system (all four wastewater treatment plant trains and three pump stations for eight collection areas); although it will require 200-250 gallons of fuel per hour (4,800 – 6,000 gallons per day) to operate the limited service portion of this project (two of the four wastewater treatment plant trains and two pump stations for three collection areas).

Currently, no contract exists to provide the fuel needed to operate the generators at the wastewater treatment plant and pump stations. The inspection team was told that the Ministry of Municipalities and Public Works would be responsible for providing the fuel. Unfortunately, the Ministry of Municipalities and Public Works has not yet committed to



providing the fuel that will be required to run the wastewater treatment plant and three pump stations.

This sustainability issue presents a serious problem for both the U.S. government and the Government of Iraq. Specifically, if the Government of Iraq cannot provide an adequate amount of fuel to continuously operate the wastewater treatment plant and pump stations, the Falluja Waste Water Treatment System will not operate, and the substantial investment by the U.S. government will be wasted.

5. Determine if project results are or will be consistent with their original objectives.

The results of the Falluja Waste Water Treatment System project will not be consistent with either the original or revised project objectives. Originally, the project objective was to provide a comprehensive wastewater treatment system for the entire city of Falluja; however, due to significantly increased costs and project delays, the objective was modified to provide the backbone to the wastewater treatment system (i.e. wastewater treatment plant, pump stations, and trunk lines) and make it available to only three of Falluja's eight collection areas. The original intent was to provide house-connection pipes to within one meter of the property line, and the Ministry of Municipalities and Public Works would be responsible for making the connections from each house to the collection system. In a cost-saving measure, the Ministry has proposed allowing each homeowner to make the connection to the collection system. Camp Falluja Resident Office representatives are concerned about this proposal: they believe homeowners will simply knock a hole through the manhole walls, damaging the collection system. Without house connections to the collection systems, there will be no method of transferring wastewater from individual houses to the wastewater treatment system. Currently, neither the U.S. government nor the Government of Iraq has funding in place to perform the house connection work; therefore, no Falluja residents will benefit from the wastewater treatment system.

In addition, a number of contractors with contracts funded by the Development Fund for Iraq have not received payment for their work on the wastewater treatment system for extended time periods. For example, the contractor who constructed the Force Main pipeline is owed approximately \$1.3 million by the Iraqi Ministry of Finance under his contract. The Iraq Transition Assistance Office has been actively pursuing the payment of the Development Fund for Iraq funded contracts with the Ministry of Finance. Subsequent to the issuance of the draft report, the Iraq Transition Assistance Office representatives stated that two payments, totaling approximately \$570,000, have been made by the Ministry of Finance.

According to U.S. government representatives, the Ministry of Finance is "days away" from making the payment to the contractor; however, this payment is almost two years overdue. Until payment is received, the contractor has denied use of the Force Main pipeline to the wastewater treatment system by locking the manholes and valve boxes. Without the use of the Force Main pipeline, no wastewater will travel from Pump Station F1 to the wastewater treatment plant.

## Recommendations

To protect the U.S. government's investment of approximately \$98 million, SIGIR recommends that the Iraq Transition Assistance Office Director:

1. Coordinate efforts with the Government of Iraq to ensure that an adequate amount of fuel is provided until permanent, reliable power is available to operate the wastewater treatment plant and the pump stations.



2. Coordinate efforts with the Government of Iraq to ensure a solution to permanent power for the wastewater treatment plant and pump stations.
3. Coordinate with the Government of Iraq to guarantee that the house connections are made to tie the three collection areas into the sewer network system.
4. Continue efforts with the Government of Iraq to ensure that the remaining contractors with outstanding balances from the Development Fund for Iraq contracts are paid.

## **Management Comments**

SIGIR received comments on the draft of this report from the U.S. Embassy-Iraq, concurring with the recommendations in the report. Specific comments were also provided to clarify technical aspects of the report. The Gulf Region Division of the U.S. Army Corps of Engineers also provided technical comments for clarification. SIGIR reviewed the comments provided by both the U.S. Embassy-Iraq and the Gulf Region Division and revised the final report as appropriate.

## **Evaluation of Management Comments**

SIGIR appreciates the concurrence by the U.S. Embassy-Iraq with the draft report's recommendations to coordinate efforts with the Government of Iraq to ensure an adequate amount of fuel is provided, a solution to the permanent power required to operate the wastewater treatment plant and pump stations, and house connections are made; while continuing to pursue payment with the Government of Iraq for the outstanding balances owed to contractors who performed under Development Fund for Iraq funded contracts.

SIGIR reviewed the information and clarifying comments provided by the U.S. Embassy-Iraq and the Gulf Region Division and revised the final report as appropriate. However, SIGIR disagrees with the U.S. Embassy-Iraq's clarifications regarding the house connections and number of Falluja citizens to be serviced by the wastewater treatment system. Specifically, the issue is the Ministry of Municipalities and Public Works connecting the individual houses to the collection system pipeline. The Ministry of Municipalities and Public Works may have "verbally committed" to completing the connections; however, according to the Gulf Region Division, the Ministry does not have available funding to perform this work. Instead, the Ministry is proposing to allow each homeowner to make his own connection to the collection system; a proposal U.S. Army Corps of Engineers representatives are "extremely concerned" about, because homeowners likely will damage the collection system.

As a result, Gulf Region Division representatives have stated that if the Ministry cannot fund the house connections, the "back up plan" is for the U.S. government to use Economic Support Funds. Until this issue is addressed and resolved, the residents of Falluja will not benefit from the wastewater treatment system. In addition, the "flow of sewage in completed parts of the sewer network" does not indicate that "some connections have already been completed;" any sewage in the network is the result of illegal taps into the system, which SIGIR covers in the body of this report. In addition, according to the Gulf Region Division documentation, the design capacity of the wastewater treatment plant is 40,000 cubic meters per day, not 48,000 cubic meters per day. Also, since the population continues to expand due to security improvements, it is not certain that the entire system, when completed, will be able to sufficiently accommodate all citizens of Falluja.

The original objective of this project was to provide a wastewater treatment system for the entire city of Falluja (eight collection areas), which will require the wastewater treatment plant to



simultaneously employ all four treatment trains and three individual pump stations operating at design capacity. The Gulf Region Division agrees with our assessment that to operate the entire wastewater treatment system at its designed capacity, 520 gallons of fuel per hour (12,480 gallons per day) will be required. However, the Gulf Region Division stated that since the project has been de-scoped to only service three collection areas, less fuel is required. Specifically, the U.S. government is projecting the wastewater treatment system will be partially operational in April 2009 (only two of the four wastewater treatment plant trains and two pump stations), for which the Gulf Region Division estimated that 200-250 gallons of fuel per hour (4,800 – 6,000 gallons of fuel per day) will be required.

Gulf Region Division representatives have previously stated that the Government of Iraq “will not be left in a difficult situation without any warning, as coordination efforts will be made in advance” regarding the fuel issue. The wastewater treatment system will be partially operational in April 2009; the Government of Iraq needs to quickly implement a system in place to provide a total of at least 4,800 – 6,000 gallons of fuel per day to multiple sites throughout the city of Falluja on a daily basis. However, after the Government of Iraq completes the remaining portions of the wastewater treatment system, this requirement will escalate to 12,480 gallons per day. The lack of fuel, even if for only a single day, could result in the back up of wastewater into the houses of Falluja residents.



## Appendix A. Scope and Methodology

---

SIGIR performed this project assessment from August through October 2008 in accordance with the Quality Standards for Inspections issued by the President's Council on Integrity and Efficiency. The assessment team comprised an engineer/inspector and two auditor/inspectors.

In performing this Project Assessment SIGIR:

- Reviewed contract documentation to include the following: Contract W914NS-04-D-0008, Delivery Order 0008, Delivery Order 0008 Modifications, including Statements of Work, Invoices, and Material Inspection and Receiving Reports, and the subsequent 45 contracts issued after the termination of the Delivery Order;
- Reviewed the available design packages (drawings and specifications);
- Interviewed the U.S. Army Corps of Engineers Gulf Region Division and Gulf Region Central personnel, Iraq Transition Assistance Office personnel, and Joint Contracting Command – Iraq/Afghanistan personnel; and
- Conducted two on-site assessments and documented the results of the Falluja Waste Water Treatment System project in Falluja, Iraq.

SIGIR subjectively chose to review and assess five of the 45 contracts awarded after the termination of the FluorAMEC contract in September 2005. The contracts provide coverage of all three funding sources and multiple facets of the project, such as earthworks for and construction of the wastewater treatment plant and pump stations, repair of Collection Area A, and the force main.

**Scope Limitation.** Due to security concerns, on each occasion we performed an expedited assessment. The time allotted for the WWTP and the pump station was approximately one hour and 30 minutes, respectively; therefore, a complete review of all work completed was not possible.



## Appendix B. Sanitation Services/WWTPs

---

Wastewater treatment plants (WWTPs) remove harmful pollutants from domestic and industrial liquid waste so that it is safe to return to the environment. Most WWTPs include the physical, chemical, and biological processes to remove physical, chemical, and biological contaminants. Waste water, such as household waste liquid and solids from toilets, baths/showers, kitchens, and sinks, travels from individual residences and businesses through sanitary sewer pipes to lift stations, and force mains to WWTPs, where it is treated. The treated water is either returned to streams, rivers, and oceans or reused for irrigation and landscaping. The solids that are removed during treatment are transported to a landfill, incinerated, or used for fertilizer.

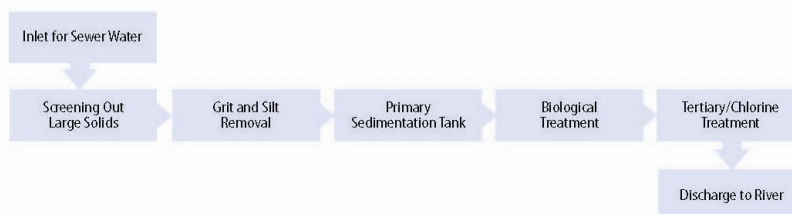
There are many different types of WWTPs, but generally at most larger WWTPs, wastewater is run through a multi-stage treatment process prior to discharge into the environment or reuse (Figure 8). The first stage of the treatment process consists of screens to remove the larger solid materials, such as wood, metals, and plastics, and then the removal of grit and silt particles, which are abrasive to plant equipment. The next stage passes the wastewater through a primary sedimentation tank where solid particles are removed from the suspension by gravity settling. Most of the solids settle to the bottom of the tanks and form a watery sludge, which is removed for separate treatment. Then a biological process breaks down dissolved and suspended organic solids by using naturally occurring micro-organisms. This occurs in an aeration tank where air is blown into the wastewater to provide oxygen for mixing and to promote the growth of the beneficial micro-organisms. From the aeration tanks, the mixture of wastewater and micro-organisms passes into a clarifier (secondary sedimentation tank) where the biomass settles under gravity to the bottom of the tank and is concentrated as sludge. Most WWTPs use disinfection for tertiary treatment to reduce pathogens, which are micro-organisms that can pose a serious risk to human health. Chlorine gas is the most widely used disinfectant and is generally injected into the treated wastewater stream for disinfection.

### **Deteriorating Condition of Water Infrastructure Prior to Operation Iraqi Freedom**

Since 1991, Iraq's sanitation sector experienced a steady decline due to issues such as aging infrastructure, poorly maintained equipment, and low technical capacity. By 2000, decades of wars, deferred maintenance, lack of spare parts, weakened technical and management capacity, and neglect resulted in serious degradation of Iraq's infrastructure, including sanitation systems. An international assessment reported the following conditions in Iraq as of 2000:

*“Diseases related to unsafe water and poor sanitation reached alarming rates, with humanitarian organizations reporting that one-third of all children in the south and central governorates were suffering from malnutrition, and mortality rates more than doubled in the last decade...many water and sewage treatment plants were providing unacceptable levels of treatment.”*

WWTP MULTI-STAGE TREATMENT PROCESS





## Appendix C. Individual Contracts Awarded

Item #	Contract #	Contractor <sup>17</sup>	Description	Original Contract Value	Deleted Scope Value
1	W917BG-05-A-0005		Piping Materials	\$481,070.00	\$0.00
2	W917BG-05-A-0007		Piping Materials	\$334,845.00	\$0.00
3	W917BG-05-A-0009		Piping Materials	\$497,500.00	\$0.00
4	W917BG-05-A-0020		Piping Materials	\$325,644.00	\$0.00
5	W917BG-05-A-0022		Piping Materials	\$207,540.00	\$0.00
6	W917BG-05-A-0023		Piping Materials	\$473,836.00	(\$473,836.00)
7	W917BG-05-A-0024		Piping Materials	\$407,400.00	\$0.00
8	W917BG-05-A-0026		Piping Materials	\$455,000.00	\$0.00
9	W917BG-05-A-0029		Piping Materials	\$497,045.00	(\$497,045.00)
10	DFIWAT-06-C-0021		Piping Materials	\$668,556.00	\$0.00
11			Piping Materials (DFI) including GRP for T0 TM	\$1,156,344.00	\$0.00
12	DFIWAT-06-M-0003		Pumps and MCCs	\$1,609,230.00	(\$1,609,230.00)
13	DFIWAT-06-C-0026		Generators (Base bid + Mod)	\$2,000,000.00	(\$2,000,000.00)
14	DFIWAT-06-C-0025		Transformers	\$185,238.00	(\$185,238.00)
15	DFIWAT-06-C-0016		Clarifier Equipment	\$802,896.00	(\$802,896.00)
16	DFIWAT-06-C-0002		Transportation of Compact Units	\$60,000.00	
17	W917BG-06-C-0048		Sewer Laydown Area (Phase I)	\$719,000.00	(\$167,506.00)
18	W917BG-08-C-0060		Sewer Laydown Area (Phase II)	\$81,000.00	\$0.00
19			Life Support Assistance GRC	\$372,750.00	\$0.00
20	W91GY1-06-M-0004		Design Services	\$497,118.00	\$0.00
21	Task Order 14		Design Reach Back (Ph I) Task Order 14 (part)	\$1,400,000.00	\$0.00
22	W91GDW-08-M-4015		Design Reach Back (Ph II)	\$954,000.00	\$0.00
23	W917BG-06-A-0213		Title 2 QA Site Support (Ph I)	\$1,359,939.88	\$0.00
24	W917BG-08-C-0037		Title 2 QA Site Support (Ph II)	\$1,166,878.00	\$0.00
25	DFIWAT-06-C-0003		Topographical and Geotechnical Works	\$110,000.00	\$0.00
26	W91GY1-06-C-0048		Area A Collection System (Base + Mod)	\$2906420.00	\$0.00
27	W91GY1-06-C-0005		Area B Collection System (Base + Mods)	\$5,004,565.00	(\$2,369,677.09)
28	W917BG-08-C-0083		Area B Collection System (Base)	\$2,251,585.00	\$0.00
29	W91GY1-06-C-0004		Area C Collection System (Base Bid)	\$3,365,391.80	(\$9,178.90)
30	W91GY1-06-C-0049		Trunk Main T1& T2 (Base Bid)	\$3,232,540.00	(\$1,624,886.79)
31	W917BG-08-C-0062		Trunk Main T1& T2 (Re-Award)	\$1,959,622.00	\$0.00
32	W91GY1-06-C-0003		Trunk Main T0 & T3 (Base Bid)	\$3,495,415.58	\$0.00
33	DFIWAT-06-C-0023		Force Main (Base Bid + Mod)	\$2,294,800.00	(\$490,851.00)

<sup>17</sup> Due to the still volatile security situation in Falluja, SIGIR will not address any of the contractors or subcontractors currently working at a project site by name.



34	W917-BG-06-C-0125		Pump Station F1 (Base Bid + Mods)	\$8,176,856.52	(\$953,384.00)
35	W91GY1-06-C-0050		Pump Station F5 (Base Bid + Mods)	\$4,570,300.00	\$0.00
36	DFIWAT-06-C-0017		11kV Electricity Supply Lines (Base Bid + Mod)	\$844,518	(\$42,099.00)
37	DFIWAT-06-C-0027		WWTP Earthworks (Base Bid)	\$4,621,937.00	(\$1,853,050.00)
38	W91GY1-06-C-0047		WWTP (Base Bid All Options + Mods)	\$29,558,290.64	\$0.00
39	DFIWAT-06-C-0024		Outfall (Base Bid)	\$2,615,000.00	(\$1,195,000.00)
40	W917BG-06-D-0021		WWTP Additional Buildings	\$1,073,858.00	\$0.00
41	W91GET-08-M-1215		WWTP Workshop Tools and Equipment	\$106,571.00	\$0.00
42	W91GET-08-M-1204		WWTP laboratory Equipment	\$26,163.32	\$0.00
43	W91GET-08-M-1216		Rolling Stock - Jetting Trucks	\$460,000.00	\$0.00
44	W91GET-08-M-1217		Rolling Stock - Mobile Pump & Fork Lift	\$185,000.00	\$0.00
45	W91GET-08-M-1213		Rolling Stock - Gators	\$23,929.00	\$0.00
			<b>Total</b>	<b>\$93,595,592.74</b>	<b>(\$14,273,877.78)</b>
			<b>Project Total (including deleted scope value)</b>	<b>\$79,321,714.96</b>	



## Appendix D. U.S. Government Response to MMPW Over Concerns With Lagoon Systems

---

### **MMPW Concerns about Lagoon Systems**

In a letter presented to SPCOC, MMPW expressed several concerns about the lagoon system recommended above. We understand that many lagoon systems in use today were designed at a time when the principles of lagoon hydraulics were poorly understood. Nowadays we count with more than enough computational power to analyze the fluid dynamics of the flow of wastewater through a sewage lagoon system. With the current technology the flow can be modeled and then optimized for improved water quality. This is important because so much of a lagoon's ability to stabilize sewage is dependent upon the exposure to the stabilization effects of the system. In other words, the poor performance of many existing lagoons in use today are the results of poor design with low retention times, which is not the case for the recommend lagoon system described above.

The statements addressed below were extracted from the letter handed by MMPW, and although some concerns have already been answered throughout this document, they are addressed in detail.

#### **1. The result of water after treatment does not comply with International standards, therefore, not considered to be an efficient method.**

The lagoon system is a reasonably efficient system used all around the world both in developed countries and undeveloped countries. Lagoon systems are used not only for domestic wastewater, but also for complex industrial effluents. The fact that every single text book on environmental engineering provides a section for properly design such systems, proves that this is a current viable and efficient solution. The proposed lagoon system has been designed following universally accepted design methods to provide a required quality effluent.

#### **2. This method leads to rising of the level of underground water in the city; therefore, using it in Falujah where underground water is very high will not be useful.**

The lagoons are designed with a geo-membrane impermeable liner to avoid water seepage into the aquifer. The geotechnical survey conducted at the proposed location indicates that the groundwater level varies between 2.0 and 2.8 m below ground level. The proposed location is 5 km south of the City of Fallujah, east of Euphrates River and north of an irrigation canal. From simple inspection of the local topography, it can be assumed that the hydro-geological conditions will result in a seepage flow regime from the proposed location toward the river or the canal and away from the City.

#### **3. Leads to the arising of stinking odor.**

The odors in an anaerobic pond are the result of oxidation in the system that produces gaseous sulfide emissions ( $H_2S$ ). Recent research conducted at the Universite du Montpellier, France, using biological covers (made out of floating peat beds) resulted in a reduction of the sulfide emission rate by 84.6%. When used in combination with plants such as algae (*Juncus Effusus* L.) and iron (addition of  $Fe_3+$  as  $FeCl_3$ ) to the peat bed, the performance improved significantly to reach a  $H_2S$  removal of 95.5%. The algae also add dissolved oxygen to the system which help to oxidize the decay process. Additionally, another mitigation measures can be implemented such as planting trees around the facility and spraying the pond surface with commercially available odor-control product on a regular basis.



## Appendix D. U.S. Government Response to MMPW Over Concerns With Lagoon Systems

---

The production of sulfides, odors, are found in all systems considered, including activated sludge systems where the mitigation measures can actually be more expensive as they should be tailored to prevent mechanical equipment failure.

### **4. Helps in the development of all kinds of insects.**

Insects can be controlled by different means including a regular disinfection (spraying) program. However, insects select still water to lay eggs where larvae have a chance to grow into mature stage. The lagoon systems are not still systems, on the contrary, they are designed to allow wastewater to flow continuously. If properly done, the design detention times should prevent insect larvae to grow in significant way in the lagoons.

### **5. Demands specialized staff for administration and operation**

Not concur. These systems are designed to be operational without continuous supervision. System maintenance is limited to dredging the lagoons once a year and regular check ups of the blowers and mechanical aerators, if any. Administrative staff should be even less than that required for activated sludge systems where continuous monitoring of the mechanical components and supply of chemicals used for process are necessary. A testing laboratory is a must at any system to guarantee effluent quality, however, the testing program in a lagoon system can be limited to once a week, compared to daily in an activated sludge system where unsatisfactory results may indicate poor performance of the mechanical equipment, the operation and maintenance, or both.

### **6. Demands wide areas of owned land to implement the tanks which increases the cost of the project.**

The recommended lagoon system will require more land than other options but with the benefit of providing more capacity as well. If compared to the alternative to use four MMPW Compact Sewage Treatment units set in parallel, the difference of cost in land requirement becomes insignificant if compared to the costs for units, construction and installation.



## Appendix E. Technical Comparison of Treatment Systems

	<b>Lagoon System</b>	<b>Construction Sewage Treatment Compact Unit (Activated Sludge Unit)</b>
Description of Treatment System	Series of anaerobic, facultative and maturation ponds. Chlorination provided for by-pass channel and Parshall Flume for flow control.	Conventional Activated Sludge Treatment with Steel Process Unit Tanks.
Flow Treatment Capacity	42,500 m <sup>3</sup> /day	
Max Number of People can be served per Unit.	212,500	50,000
Number of Units required	1	4
Performance (Design effluent quality at 25 degrees C)	BOD<20 mg/l TSS<30 mg/l (most of the time)	Unknown (subject to detailed review)
Land Required (per unit)	650 x 750 m	150 x 150 m
Land Required Total	650 x 750 m	The use of four units will require redesigning the whole system to avoid redundancy of control equipment. If plants are to be put in parallel as stand-alone independent units, the land requirement would be 600 x 600 m
Power Requirements	<100 KW (whole plant)	200 KW per unit
Operation required	None.	Qualified Trained Personnel. Continuous monitoring.
Maintenance Requirement	Low, dredge lagoon once a year	High. Continuous monitoring.
Upgrade to improve effluent quality (if required)	Addition of mechanical aerators.	Tertiary treatment
Effluent Usage	Direct discharge into river or used for irrigation (unrestricted)	Direct discharge into river or used for irrigation (unrestricted)
Supporting Infrastructure requirements	Access roads, Supporting buildings, security fence	Site preparation, access roads, concrete foundation for tanks, supporting buildings
Reliability of Continuous Operation	It will work under any conditions	Requires standby or alternate power system. System will stop if equipment or instrumentation failure occurs.
ESTIMATED CONSTRUCTION COST	\$250 per m <sup>3</sup> treated <sup>18</sup>	\$1,040 per m <sup>3</sup> treated <sup>19</sup>

<sup>18</sup> Based upon preliminary Independent Government Estimate.

<sup>19</sup> Estimated from construction cost posted by El Concorde Construction in its website.



## Appendix F. Falluja WWTP DFI Payments as of 12-31-07

<b>Fallujah WWTP DFI Update - As of 31 DEC 2007</b>								
<b>Contract # &amp; Invoice #</b>	<b>Date submitted</b>	<b>Invoice Amount</b>	<b>Voucher No.</b>	<b>Status</b>	<b>Contract Amt - \$</b>	<b>Amt Apprvd to Date - \$</b>	<b>Amt Paid to Date - \$</b>	<b>Outstanding Payments - \$</b>
Force Main - DFIWAT-06-C-0023 INV # 1	11-Oct-06	\$321,726	N/A - Prior to Vouchers	Paid	\$2,377,200	\$1,886,349	\$557,474	\$1,328,875
Force Main - DFIWAT-06-C-0023 INV # 2	15-Nov-06	\$364,219	2709	Unpaid				
Force Main - DFIWAT-06-C-0023 INV # 3	6-Dec-06	\$579,977	2684	Unpaid				
Force Main - DFIWAT-06-C-0023 INV # 4	23-Dec-06	\$160,678	2722	Unpaid				
Force Main - DFIWAT-06-C-0023 INV # 5	28-Jan-07	\$235,748	2738	Paid o/a 10 SEP 07				
Force Main - DFIWAT-06-C-0023 INV # 6	12-Jul-07	\$224,000	2746	Unpaid				
Earth works -DFIWAT-06-C-0021 INV #1	2-Oct-06	\$1,341,120	N/A - Prior to Vouchers	Paid	\$4,621,937	\$2,768,887	\$2,451,795	\$317,092
Earth works -DFIWAT-06-C-0021 INV #2	16-Nov-06	\$317,092	2658	Unpaid				
Earth works -DFIWAT-06-C-0021 INV #3	4-Apr-07	\$1,110,675	2736	Paid o/a 1st week of SEP 07				
11kv Feeder-DFDIWAT-06-C-0017 INV #1	5-Nov-06	\$94,500	N/A - Prior to Vouchers	Paid	\$844,518	\$802,419	\$264,654	\$537,765
11kv Feeder-DFDIWAT-06-C-0017 INV #2	6-Dec-06	\$373,422	2678	Unpaid				
11kv Feeder-DFDIWAT-06-C-0017 INV #3	13-Jan-07	\$118,434	2737	Paid o/a 1st week of SEP 07				
11kv Feeder-DFDIWAT-06-C-0017 INV #4	22-Mar-07	\$51,720	2737	Paid o/a 1st week of SEP 07				
11kv Feeder-DFDIWAT-06-C-0017 INV #5	17-Jul-07	\$164,343	2745	Unpaid				
Outfall-DFIWAT-06-C-0024 Inv #1	29-Aug-06	\$298,000	N/A - Prior to Vouchers	Paid	\$2,615,000	\$1,420,000	\$1,420,000	\$0
Outfall-DFIWAT-06-C-0024 Inv #2	3-Oct-06	\$471,000	N/A - Prior to Vouchers	Paid				
Outfall-DFIWAT-06-C-0024 Inv #3	15-May-07	\$651,000	2735	Paid o/a 1st week of SEP 07				
<b>Total</b>					<b>\$10,458,655</b>		<b>\$4,693,923</b>	<b>\$2,183,732</b>



## Appendix G. Falluja WWTP DFI Payments as of 8-4-08

Contract Number	Contractor <sup>20</sup>	Scope of Work	Contract Value	Total Value of Work Completed	Total Invoices Submitted	Total Payments Received	Total Unpaid Invoices
DFIWAT-06-M-0001		Transport Units	\$ 63,000	\$ 63,000	\$ 63,000	\$ 25,200	\$ 37,800
DFIWAT-06-C-0003		Geotech/Survey	\$ 110,000	\$ 110,000	\$ 110,000	\$ -	\$ 110,000
DFIWAT-06-C-0017		11 kV feeder	\$ 844,518	\$ 802,419	\$ 802,419	\$ 264,654	\$ 537,765
DFIWAT-06-C-0023		Force main	\$ 2,377,200	\$ 2,377,200	\$ 2,377,200	\$ 557,474	\$ 1,328,875 <sup>21</sup>
DFIWAT-06-C-0027		Earthwork	\$ 4,621,937	\$ 2,768,887	\$ 2,768,887	\$ 2,451,795	\$ 317,092
			<b>\$8,016,655</b>	<b>\$6,121,506</b>	<b>\$6,121,506</b>	<b>\$3,299,123</b>	<b>\$2,331,532</b>
DFIWAT-06-C-0016		Clarifiers	\$ 802,896	\$ 802,896	\$802,896	\$ -	\$ 802,896 <sup>22</sup>

<sup>20</sup> Due to the still volatile security situation in Falluja, SIGIR will not address any of the contractors or subcontractors currently working at a project site by name.

<sup>21</sup> For the Force Main DFI funded contract, the contract amount (including modifications) was \$2,377,200. Of this amount, \$1,886,349 was invoiced to the MoF. A single DFI payment of \$557,474 was made, leaving an outstanding balance of \$1,328,875. The remaining un-invoiced balance of \$490,851 was added to the WWTP contract (+5 % for the contractor as a handling charge).

<sup>22</sup> The outstanding balance of \$802,896 was never paid by the MoF using DFI funds; it has now been added as a modification to an existing IRRF funded contract. Therefore, it is technically not an outstanding balance and not included in the total outstanding amount.



## Appendix H. Gulf Region Division Comments



REPLY TO  
ATTENTION OF

DEPARTMENT OF THE ARMY  
U.S. ARMY CORPS OF ENGINEERS  
GULF REGION DIVISION  
BAGHDAD, IRAQ  
APO AE 09348

CEGRD-CG

21 October 2008

MEMORANDUM FOR Special Inspector General for Iraq Reconstruction, US Embassy Annex,  
M-202, Old Presidential Palace, APO AE 09316

SUBJECT: Draft SIGIR SIGIR Draft Project Assessment Report - Falluja Waste Water  
Treatment System Falluja, Iraq (SIGIR - PA-08-144 to PA-08-148)

1. This memorandum provides the U.S. Army Corps of Engineers, Gulf Region Division response to the subject draft project assessment report.
2. The Gulf Region Division reviewed the subject draft report and generally agrees with the facts as presented in the report. GRD provides additional comments for clarity and accuracy in the enclosure.
3. Thank you for the opportunity to review the draft report and provide our written comments for incorporation in the final report.
4. If you have any questions, please contact Mr. Robert Donner at (540) 665-5022 or via email [Robert.L.Donner@usace.army.mil](mailto:Robert.L.Donner@usace.army.mil).

Encl  
as

*Michael R. Eyre*  
MICHAEL R. EYRE  
Major General, USA  
Commanding



## Appendix H. Gulf Region Division Comments

---

### COMMAND REPLY

to

**SIGIR Draft Project Assessment Report - Falluja Waste Water Treatment System  
Falluja, Iraq**

**(SIGIR Report Number PA-08-144 to PA-08-148)**

**(Projects PA-08-144 to PA-08-148)**

**Overall Comment.** The Gulf Region Division (GRD) reviewed the draft report and provides the following comments.

1. **Draft Report, Pages v, first paragraph, last sentence and on pages 51 and 56.** According to Camp Falluja Resident Office representatives, it will take 520 gallons of fuel per hour (12,480 gallons per day) to operate the generators at the wastewater treatment plant and three pump stations.

**Command Comment.** The requirement of 520 gal/hr of generator fuel was calculated for the full system running with all generators at 100% loading. However, with only 3 collection areas connected, only 2 of the WWTP's 4 trains will need to operate. This reduces the power draw for the plant roughly in half. In addition, Pump Station F5 is designed to push sewage through trunk lines T1 and T2, which have no collection systems feeding them at this time, so F5 will not be in operation. Lastly, the generators are sized so they will not be loaded at 100% capacity. Subtracting these items, the system will require an estimated 200-250 gallons of fuel per hour.

2. **Draft Report, Pages v and 57.** Coordinate efforts with the Government of Iraq to ensure a solution to permanent power for the wastewater treatment plant and pump station.

**Command Comment.** The last word should read "stations" (plural) instead of "station".

3. **Draft Report, Page 1, third paragraph, fifth sentence.** Next the wastewater enters an aeration tank where air is blown into the wastewater to provide oxygen for mixing and to promote the growth of the beneficial micro-organisms.

**Command Comment.** Revise the sentence to state, "This occurs in an aeration tank where air is blown into the wastewater to provide oxygen for mixing and to promote the growth of the beneficial micro-organisms." The breakdown of organics by micro-organisms occurs in the aeration tank, not prior to entering the tank, since the micro-organisms require oxygen to thrive, thus the aeration.



## Appendix H. Gulf Region Division Comments

---

collect and store sewage during temporary power outages at the plant.

4. **Draft Report, Page 12, first paragraph, last sentence.** Ultimately, because of too many unknowns, instead of completing the WWTP, pump stations, and the entire collection system for \$32.5 million, FluorAMEC was able to only complete Collection Area A for approximately \$23 million.

**Command Comment.** Change \$23 million to \$18.7 million to reflect the correct cost. This is the cost reported on page 17 and the figure shown in the Resident Management System (RMS).

5. **Draft Report, Page 23, Contracting in a Combat Zone section.**

**Command Comment.** SIGIR reported on the analysis of construction delays caused by application of the FARs in combat zones in its report, Iraq Reconstruction: Lessons in Contracting and Procurement published in July 2006. The primary recommendation was to create a Contingency FAR to streamline or remove some of these obstructions to post-conflict reconstruction. Perhaps, SIGIR needs to add a reference to this report to show that the situation has not improved.

6. **Draft Report, Page 28, first full paragraph, fifth sentence.** According to Camp Falluja Resident Office documentation, the settlement of the terminated contract has been prolonged due to contractor flexibility.

**Command Comment.** Change “flexibility” to inflexibility.

7. **Draft Report, Page 28, first full paragraph, last sentence.** Currently, the re-award package is out for bids and is tentatively scheduled for award in October 2008.

**Command Comment.** The replacement contract to finish Collection Area B was awarded on 30 Sep 08.

8. **Draft Report, Page 39, last paragraph.** The U.S. government’s design team determined that influent flow rates were expected to exceed the pumping and treatment of the plant, which would result in raw sewage discharging directly into the Euphrates River. The WWTP was redesigned with surge storage basin capacity to accommodate anticipated influent wastewater flows that exceed the combined pumping ability of the package treatment system. Specifically, two 10,000m<sup>3</sup> basins and associated return pump station to facilitate control and provide for cleaning and maintenance.

**Command Comment.** The statement that influent flow rates could exceed the treatment plant’s capacity is based on extremely conservative/worst case scenarios. GRD does not expect that this will ever happen, especially with only 3 collection areas connected. The plant (when completed) will have more than double the capacity of anticipated influent flows. The requirement for the surge basins at the wastewater treatment plant is also to collect and store sewage during temporary power outages at the plant.



## **Appendix H. Gulf Region Division Comments**

---

9. **Draft Report, Page 41, first paragraph.** IRRF funded Contract W917-BG-06-C-0125 was awarded to a local national contractor on 1 June 2006 in the amount of \$3,490,379. The objective of the contract was to construct Pump Station F1 (F1).

**Command Comment.** Contract W917-BG-06-C-0125 is CERP-funded. This contract also included Pump Stations F2 and F3. Pump station F3 was de-scoped from the contract.



# Appendix I. U.S. Embassy-Iraq Comments

---



*Embassy of the United States of America*

Baghdad, Iraq

October 20, 2008

Mr. Brian Flynn  
Assistant Inspector General For Inspections  
Special Inspector General for Iraq Reconstruction

Dear Mr. Flynn:

We appreciate the effort and research that has gone into SIGIR's efforts to review the evolution of the Fallujah Waste Water Treatment System (WWTS) project and associated contracts. We accept the recommendations and will continue all efforts to implement them. In reviewing the material and the recommendations made, we have a few observations.

To ensure that sufficient fuel is available to power the WWTS, ITAO is actively engaging the Fallujah Sewage Director General through monthly meetings with the Ministry of Municipalities and Public Works (MMPW).

The report further recommends that ITAO coordinate with the Government of Iraq (GOI) to ensure a permanent, reliable power supply. The scope of the project includes connecting the WWTS to the national power grid. At this time, the national grid in Fallujah is capable of providing only four hours of power per day on average. ITAO is engaging the Iraqi Ministry of Electricity in an effort to connect the WWTS to a dedicated essential services circuit, which in principal receives 24/7 hours of continuous power. Until a reliable connection to the national grid is assured, ITAO will continue to coordinate with the MMPW to reinforce the need to prioritize sufficient fuel for the installed diesel generators.

The report also recommends coordinating with the GOI to guarantee that house connections are made to tie the three collection areas into the sewer network system. We note for the sake of clarity that the three collection areas are already tied into the network. Per the contract requirements, collection system pipelines were installed to within 1 meter of individual property lines. The agreement was for the MMPW to connect houses to the collection system pipeline. The MMPW has verbally committed to completing these connections. Based on the flow of sewage in completed parts of the sewer network it appears that some connections have already been completed. ITAO Senior Consultants will continue to engage the MMPW to ensure that the house connections are carried out by MMPW or by local authorities.

We note that your report states that the sewer network as currently built will service only one-third of the residents originally planned. This is true, however, we clarify that the design capacity of the system and waste water treatment plant is 48,000 m<sup>3</sup>/day. This is sufficient to handle the needs of all Fallujah residents, but the MMPW must extend the sewage network into those areas of Fallujah that are outside the scope of this contract in order to service the remainder of these residents. ITAO has emphasized the need for the MMPW to budget for the installation



## **Appendix I. U.S. Embassy-Iraq Comments**

---

of the remaining collection system in their capital investment plan for next year and will continue to support the ministry in their effort to plan the expansion of the collection system.

We again thank SIGIR for undertaking this review. With the few clarifications noted above, we accept the observations made and will continue to implement the recommendations.

Sincerely,

A handwritten signature in dark ink, appearing to read 'M. M. Wall'.

Marc M. Wall  
Ambassador  
Coordinator for Economic Transition in Iraq



## Appendix J. Public Notice to Falluja



### **Confined Spaces Entry** **Manholes**

- *Avoid entrance to the Manholes, life risk hazard.*
- *Confined Spaces could contain toxic gases, combustible atmospheres.*
- *The work is not done yet, please do not dump domestic sewer into the system, by dumping waste into unfinished sewer network, the network accomplishment will delay and everybody working on this network will be in danger.*

***Thanks for cooperation...***



With respect: Fallujah  
Sewer Directorate.





## Appendix K. Acronyms

---

CERP	Commanders Emergency Response Program
CF	Coalition Forces
CPA	Coalition Provisional Authority
DFI	Development Fund for Iraq
DG	Director General
DO	Delivery Order
ER	Engineering Regulation
FAR	Federal Acquisition Regulation
FSD	Falluja Sewer Directorate
GOI	Government of Iraq
GRC	Gulf Region Central
GRD	Gulf Region Division
IED	Improvised Explosive Device
IRRF	Iraq Relief and Reconstruction Fund
IRMO	Iraq Reconstruction Management Office
ITAO	Iraqi Transition Assistance Office
JCC-I/A	Joint Contracting Command – Iraq/Afghanistan
KW	Kilowatt
km	Kilometer
kV	Kilovolt
lpd	Liters per day
m <sup>3</sup> /day	Cubic meters per day
mm	Millimeter
MMPW	Ministry of Municipalities and Public Works
MoF	Ministry of Finance
MPa	Megapascals
NTP	Notice to Proceed
O&M	Operations and Maintenance
PARC	Principal Assistant Responsible for Contracting
psi	Pounds per square inch
PVC	Polyvinyl Chloride



QA	quality assurance
QAR	quality assurance representatives
QC	quality control
SIGIR	Special Inspector General for Iraq Reconstruction
SOP	Standard Operating Procedure
SOW	Statement of Work
SPCOC	Sector Project Contracting Office Contractor
USACE	U.S. Army Corps of Engineer
UXO	Unexploded Ordnance
WI/BV	Washington International, Inc./Black and Veatch
WWTP	Waste Water Treatment Plant



## **Appendix L. Report Distribution**

---

### **Department of State**

Secretary of State

Senior Advisor to the Secretary and Coordinator for Iraq

Director of U.S. Foreign Assistance/Administrator, U.S. Agency for International Development

Director, Office of Iraq Reconstruction

Assistant Secretary for Resource Management/Chief Financial Officer, Bureau of Resource Management

U.S. Ambassador to Iraq

Director, Iraq Transition Assistance Office

Mission Director-Iraq, U.S. Agency for International Development

Inspector General, Department of State

### **Department of Defense**

Secretary of Defense

Deputy Secretary of Defense

Under Secretary of Defense (Comptroller)/Chief Financial Officer

Deputy Chief Financial Officer

Deputy Comptroller (Program/Budget)

Deputy Assistant Secretary of Defense-Middle East, Office of Policy/International Security Affairs

Inspector General, Department of Defense

Director, Defense Contract Audit Agency

Director, Defense Finance and Accounting Service

Director, Defense Contract Management Agency

### **Department of the Army**

Assistant Secretary of the Army for Acquisition, Logistics, and Technology

Principal Deputy to the Assistant Secretary of the Army for Acquisition, Logistics, and Technology

Deputy Assistant Secretary of the Army (Policy and Procurement)

Commanding General, Joint Contracting Command-Iraq/Afghanistan

Assistant Secretary of the Army for Financial Management and Comptroller

Chief of Engineers and Commander, U.S. Army Corps of Engineers

Commanding General, Gulf Region Division

Chief Financial Officer, U.S. Army Corps of Engineers

Auditor General of the Army

### **U.S. Central Command**

Commanding General, Multi-National Force-Iraq

Commanding General, Multi-National Corps-Iraq

Commanding General, Multi-National Security Transition Command-Iraq

Commander, Joint Area Support Group-Central



## **Other Federal Government Organizations**

Director, Office of Management and Budget  
Comptroller General of the United States  
Inspector General, Department of the Treasury  
Inspector General, Department of Commerce  
Inspector General, Department of Health and Human Services  
Inspector General, U.S. Agency for International Development  
President, Overseas Private Investment Corporation  
President, U.S. Institute for Peace

## **Congressional Committees and Subcommittees, Chairman and Ranking Minority Member**

### **U.S. Senate**

Senate Committee on Appropriations  
    Subcommittee on Defense  
    Subcommittee on State, Foreign Operations, and Related Programs  
Senate Committee on Armed Services  
Senate Committee on Foreign Relations  
    Subcommittee on International Development and Foreign Assistance, Economic Affairs, and International Environmental Protection  
    Subcommittee on International Operations and Organizations, Democracy and Human Rights  
    Subcommittee on Near Eastern and South and Central Asian Affairs  
Senate Committee on Homeland Security and Governmental Affairs  
    Subcommittee on Federal Financial Management, Government Information, Federal Services, and International Security  
    Subcommittee on Oversight of Government Management, the Federal Workforce, and the District of Columbia  
    Permanent Subcommittee on Investigations

### **U.S. House of Representatives**

House Committee on Appropriations  
    Subcommittee on Defense  
    Subcommittee on State, Foreign Operations, and Related Programs  
House Committee on Armed Services  
    Subcommittee on Oversight and Investigations  
House Committee on Oversight and Government Reform  
    Subcommittee on Government Management, Organization, and Procurement  
    Subcommittee on National Security and Foreign Affairs  
House Committee on Foreign Affairs  
    Subcommittee on International Organizations, Human Rights, and Oversight  
    Subcommittee on the Middle East and South Asia



## **Appendix M. Project Assessment Team Members**

---

The Office of the Assistant Inspector General for Inspections, Office of the Special Inspector General for Iraq Reconstruction, prepared this report. The principal staff members who contributed to the report were:

Angelina Johnston

Kevin O'Connor

Todd Criswell, P.E.